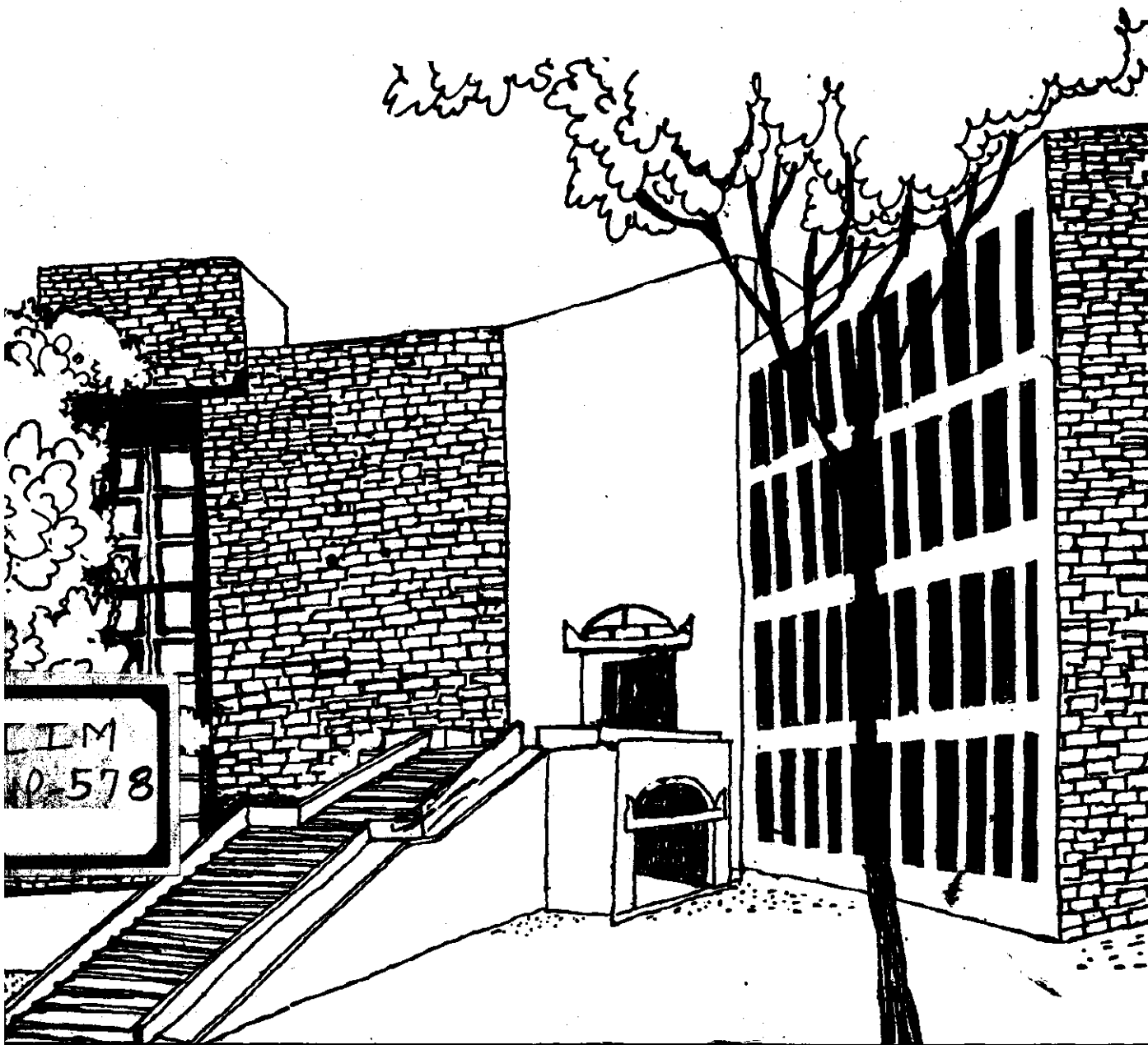


# Working Paper



POLICY ISSUES FOR LONG TERM GROWTH  
OF FERTILIZER USE IN BANGLADESH

By

Gunvant M. Desai

W P No. 578

August 1985

578  
(578)

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

INDIAN INSTITUTE OF MANAGEMENT  
AHMEDABAD-380015  
INDIA

PURCHASED

APPROVED

BY ~~EXCHANGE~~ CMA chairman

PRICE

ACC. NO.

VIKRAM SARABHAI LIBRARY

I. J. M. AHMEDABAD

## TABLE OF CONTENTS

	<u>Page</u>
List of Tables	ii
List of Figures	iv
I. INTRODUCTION	1
II. OVERVIEW OF FERTILIZER CONSUMPTION	2
Consumption in 1983/84	2
Comparison with Other Developing Countries	2
Trends in Growth in Consumption	7
Consumption vis-a-vis Potential	9
Share of Different Crops in Total Consumption	12
Proportions of Areas Fertilized and Rates of Application	18
Growth Performance of Districts in Fertilizer Consumption	34
III. POLICIES FOR LONG-TERM GROWTH IN FERTILIZER USE	46
Major Strengths and Problem Areas	46
A Framework to Discuss Policy Requirements	48
Important Policy Issues and Suggestions	51

## LIST OF TABLES

	<u>Page</u>
1. Growth of fertilizer use in Bangladesh vis-a-vis India and major states of East India, 1961/62 to 1983/84	4
2. Fertilizer consumption in Bangladesh, 1952/53 to 1983/84	8
3. Share of various crops in total fertilizer consumption in Bangladesh, 1960/61 to 1973/74	13
4. Ratios of official prices of nitrogen to procurement prices of rice and wheat in Bangladesh and India, 1967/68 to 1983/84	19
5. Findings of IFDC-BARC surveys on percentage of area fertilized and average rates of application for Aus, Aman, and Boro paddy, wheat, and jute, 1979-82	23
6. Fertilizer use by sample farmers on Aus paddy in Bangladesh, 1980-82	24
7. Fertilizer use by sample farmers on Boro paddy in Bangladesh, 1979/80 - 1981/82	25
8. Fertilizer use by sample farmers on Aman paddy in Bangladesh, 1979-81	26
9. Fertilizer use by sample farmers on wheat in Bangladesh, 1979/80 - 1981/82	27
10. Fertilizer use by sample farmers on jute in Bangladesh, 1980-82	28
11. 1983/84 fertilizer use by Bangladesh district as proportion of potential, and changes in district-wise shares, 1969/70 - 1983/84	35
12. Monthly sales, ratios of monthly opening stocks to monthly sales, and of monthly availability to monthly sales of urea, TSP, and MP in Bangladesh, 1977/78 to 1983/84	66

Appendix A

iii

- A1. Monthly opening stocks, current supply, availability, sales and closing stocks of urea in Bangladesh, 1977/78 - 1983/84 70-72
- A2. Monthly opening stocks, current supply, availability, sales and closing stocks of triple superphosphate (TSP) in Bangladesh, 1977/78 - 1983/84 73-75
- A3. Monthly opening stocks, current supply, availability, sales and closing stocks of muriate of potash (MP) in Bangladesh, 1977/78 - 1983/84 76-78

## LIST OF FIGURES

	<u>Page</u>
1. Fertilizer Nutrient Consumption per Hectare of Total Cropped Area in Various Districts of Bihar, West Bengal, Orissa, and Assam in the early 1980s	
2. Fertilizer Nutrient Consumption per Hectare of Total Cropped Area in Various Districts of Bangladesh in the Early 1980s	
3. Aus Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1980, 1981 and 1982	
4. Aman Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979, 1980 and 1981	
5. Boro Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979/80, 1980/81 and 1981/82	
6. Wheat, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979/80, 1980/81 and 1981/82	
7. Jute, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1980, 1981 and 1982	
8. Fertilizer Consumption Trends in Various Districts of Bangladesh	
9. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Urea in Bangladesh from July 1977 to June 1983	
10. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Triple Superphosphate (TSP) in Bangladesh from July 1977 to June 1983	
11. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Muriate of Potash (MP) in Bangladesh from July 1977 to June 1983	

12. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Urea in Bangladesh, 1977 to 1984
13. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Triple Superphosphate (TSP) in Bangladesh, 1977 to 1984
14. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Muriate of Potash (MP) in Bangladesh, 1977 to 1984
15. Growth of Fertilizer Consumption and Changes in Ratio of Official Price of Nitrogen to Procurement Price of Rice, Bangladesh, 1960/61 to 1983/84



# POLICY ISSUES FOR LONG TERM GROWTH OF FERTILIZER USE IN BANGLADESH

Gunvant M. Desai  
Centre for Management in Agriculture  
Indian Institute of Management, Ahmedabad

## I. INTRODUCTION

1.1 This paper discusses policy issues relevant to sustained rapid growth in Bangladesh's fertilizer consumption. Section II is an overview of fertilizer consumption as it has evolved over the years. It also provides a comparative perspective on the performance of Bangladesh among developing countries. Section III discusses policy requirements of long-term rapid growth in fertilizer use, keeping in mind various features of, and major forces behind, the past growth.

1.2 The paper concludes that, notwithstanding the policy of phasing out fertilizer subsidies adopted by the government, there is a substantial scope for growth in fertilizer use. Utilization of this scope, however, requires a new policy orientation. The emphasis on prices needs to be replaced by concentration on the productivity and efficiency of fertilizer use as key target variables in policies to raise farmers' returns on fertilizers.

---

This paper was prepared for the project "Fertilizer Pricing Policy and Foodgrain Production Strategy in Bangladesh" undertaken by IFPRI/BIDS Fertilizer Pricing Policy Study Team. The author was a member of this study team.

Research assistance received from Ms. Vijayalaxmi Chandramouli and Ms. Manjeeta Singh is gratefully acknowledged.

1.3 Different factors affecting growth in fertilizer use need to be viewed not in isolation from each other, but as a set of interacting variables which can be manipulated through policy interventions. The dominant aim of these interventions should be faster development and well-coordinated working of systems which influence the rate of growth in fertilizer use.

## II. OVERVIEW OF FERTILIZER CONSUMPTION

### Consumption in 1983/84

2.1 Fertilizer consumption in Bangladesh exceeded 500,000 metric tons of nutrients in 1983/84. In terms of materials, it was more than one million metric tons. Consumption reached 63 kilograms of net cultivated area and 41 kilograms per hectare of total cropped areas.

2.2 The view held by some, that Bangladesh's fertilizer consumption is among the world's lowest, is somewhat misleading. While Bangladesh's fertilizer consumption per hectare is considerably lower than in many developed countries, it is higher than average levels in a large number of developing countries.

### Comparison with Other Developing Countries

2.3 On the basis of 1981/82 fertilizer consumption per hectare of arable land and land under permanent crops, Bangladesh ranks 42nd among <sup>the</sup> 113 developing countries for which data are readily available.<sup>1/</sup> Its consumption in that year was nine percent lower than the average for all developing countries.

---

1/ Based on data from Food and Agriculture Organization of the United Nations, FAO Fertilizer Yearbook, (Rome: FAO), various issues.

However, if only Developing Market Economies are considered (that is, if Centrally Planned Economies are excluded from developing countries), then Bangladesh's consumption was 36 percent higher than the group's average.

2.4 Among the 34 developing countries of Asia, Bangladesh ranks 15th. But most of the developing countries with higher consumption than Bangladesh are either located in East Asia or in the Middle East. Among countries in South or Southeast Asia, Bangladesh's fertilizer consumption per hectare is lower than that of Singapore, Malaysia, Sri Lanka, Indonesia, and Pakistan. On the other hand, it is considerably higher than that of Nepal, Burma, Thailand, the Philippines, and a few others.

2.5 Bangladesh's fertilizer consumption per hectare of gross cultivated area in 1983/84 was about 8 percent lower than that of India. But it compares very favourably with states in East India (Table 1). Among these, only West Bengal's consumption was as high as that of Bangladesh, and consumption levels in Bihar, Orissa, Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, and Tripura were considerably lower than in Bangladesh.

2.6 That fertilizer consumption in Bangladesh was generally higher than in East India is also illustrated by Figures 1 and 2, which show levels of fertilizer consumption per hectare of gross cultivated area in the districts of East India and Bangladesh, respectively.

Not only is fertilizer consumption in Bangladesh higher than in a majority of the developing countries, but its growth has also been faster. In 1981/82 Bangladesh ranked third among the 40 developing countries that applied less than five kilograms of fertilizer per hectare in the early 1960s.

Table 1. Growth of fertilizer use in Bangladesh vis-a-vis India and major states of East India, 1961/62 to 1983/84

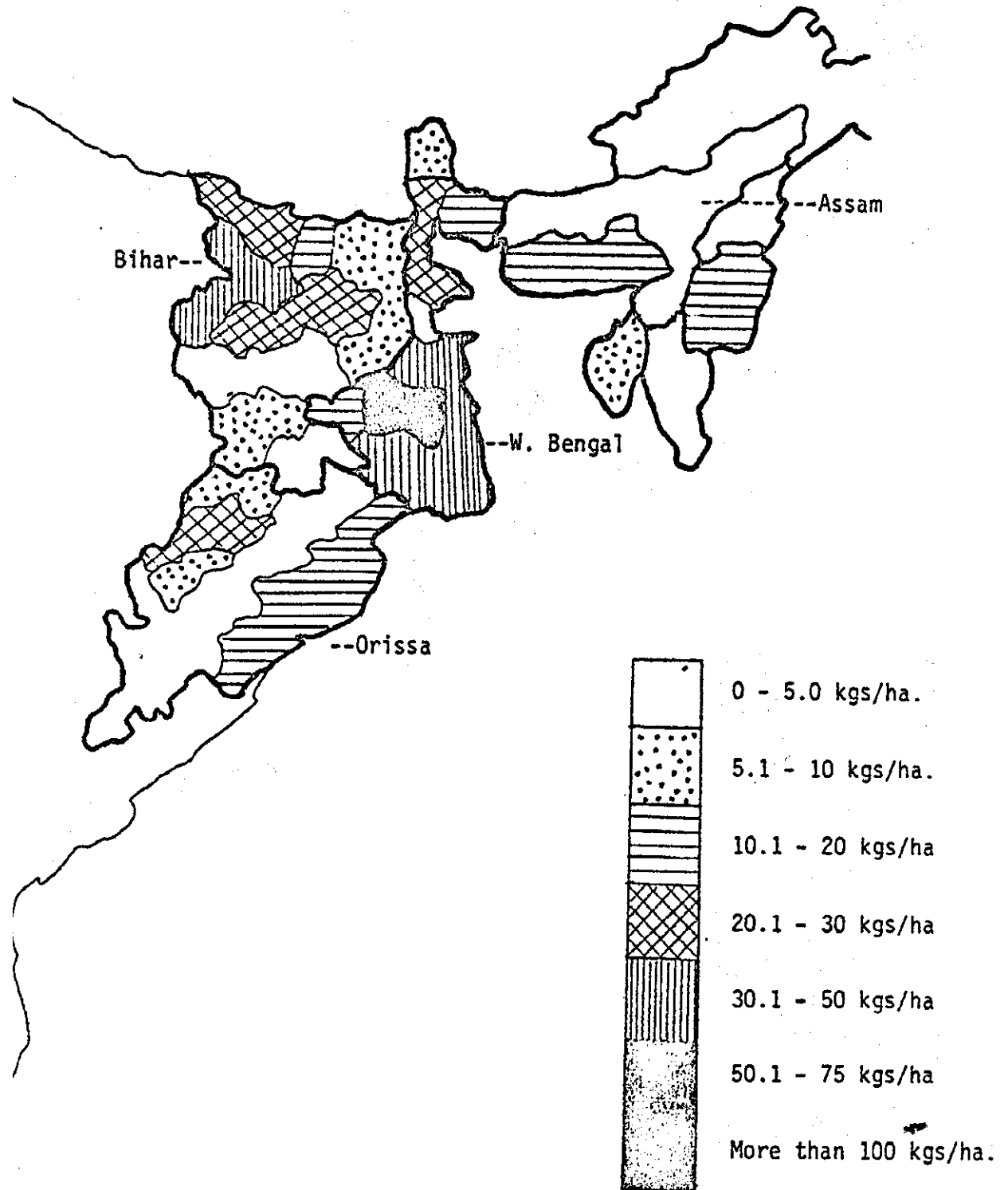
Year	Bangladesh	Major States in East India				India
		W. Bengal	Bihar	Orissa	Assam	
(Kgs of nutrients per hectare of gross cropped area)						
1961/62	2.0	3.8	1.3	0.8	a/	2.2
1962/63	2.2	3.3	1.8	0.9	0.1	2.9
1963/64	4.4	4.8	2.4	1.1	0.2	3.5
1964/65	4.1	6.5	3.1	1.3	1.0	4.9
1965/66	4.9	6.4	3.2	1.3	2.2	5.1
1966/67	6.1	5.1	3.6	2.5	1.9	7.0
1967/68	7.6	6.7	3.9	2.8	2.2	9.4
1968/69	8.2	8.0	6.1	2.9	3.3	11.1
1969/70	10.0	7.4	9.9	3.1	2.4	12.2
1970/71	11.4	11.0	9.0	3.3	3.1	13.6
1971/72	9.9	13.1	10.1	7.1	2.9	16.1
1972/73	15.1	13.0	11.5	8.1	3.3	17.1
1973/74	14.9	13.3	9.0	8.6	2.6	16.7
1974/75	10.8	16.2	10.8	6.9	1.9	15.7
1975/76	17.0	16.3	12.0	6.1	1.9	16.9
1976/77	19.6	20.0	15.2	8.6	1.3	20.4
1977/78	26.8	21.8	17.3	8.1	1.8	24.9
1978/79	27.6	30.9	17.1	8.7	2.4	29.2
1979/80	31.6	30.6	16.2	8.1	2.1	30.0
1980/81	32.3	35.9	18.0	9.2	2.8	31.5
1981/82	30.9	32.8	18.0	9.9	3.3	34.6
1982/83	34.6	33.1	18.5	10.8	4.1	36.6
1983/84	41.1	42.5	26.7	13.0	5.7	44.5

a/ Less than 0.05 kilograms.

Sources: 1) Bangladesh: Based on data from Bangladesh Ministry of Agriculture, Bangladesh Agriculture in Statistics (Dhaka, 1974); Bangladesh Bureau of Statistics, Ministry of Planning, Statistical Pocket Book of Bangladesh, 1980 (Dhaka: BBS, 1981); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1984.

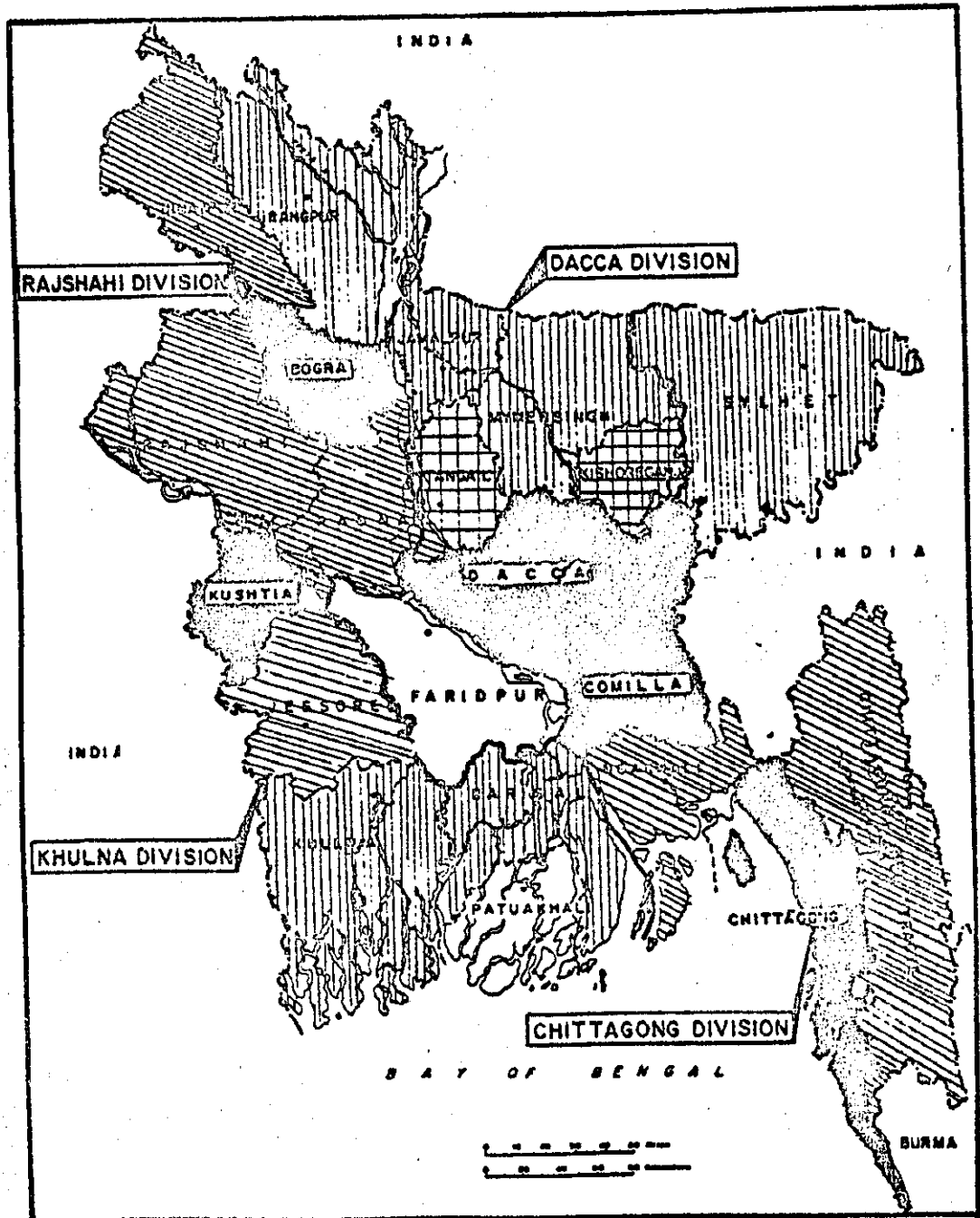
2) India: Based on data from Fertilizer Association of India, Fertilizer Statistics, (various issues); and India, Ministry of Agriculture, Indian Agriculture in Brief (New Delhi).

Figure 1. Fertilizer Nutrient Consumption per Hectare of Total Cropped Area in Various Districts of Bihar, West Bengal, Orissa, Assam, and in other Northeastern Indian States in the Early 1980s



Note: No districts fall between 75.1 and 100 kgs/ha.

Figure 2. Fertilizer Nutrient Consumption per Hectare of Total Cropped Area in Various Districts of Bangladesh in the Early 1980s



### Trends of Growth in Consumption

2.7 Table 2 shows the growth of fertilizer consumption in Bangladesh from 1952/53 to 1983/84. The period can be broadly divided as: a) 1952/53 to 1959/60, b) 1959/60 to 1970/71, c) 1970/71 to 1974/75, d) 1974/75 to 1977/78, and e) 1977/78 to 1983/84.

2.8 Total consumption grew from less than 2,000 metric tons of nutrients in 1952/53 to about 11,000 metric tons in 1959/60. Thereafter it accelerated, reaching 145,000 metric tons in 1970/71. More than 60 percent of growth during this period was recorded after 1965/66. Between 1970/71 and 1974/75 there were fluctuations in the upward trend. Fertilizer consumption reached 182,000 metric tons in 1972/73 but then dropped by 1974/75 to 129,000 metric tons, which was lower than the 1970/71 level.

2.9 The period between 1974/75 and 1977/78 recorded impressive growth, from 129,000 to 356,000 metric tons. The 1977/78 level was nearly three times the level in 1974/75 when fertilizer use was abnormally low owing to a particularly severe supply bottleneck. But growth in sales during the following three years must still be considered rapid. Fertilizer use in 1977/78 was twice that of the previous peak of 1972/73. Between 1977/78 and 1983/84, total consumption further increased from 356,000 to 544,000 metric tons (i.e., by 53 percent). More than 75 percent of the growth during this period, however, occurred in the last two years. Yet another noteworthy point is that after reaching 400,000 metric tons in 1979/80, consumption stalled in 1980/81 and 1981/82 before reaching 544,000 metric tons in 1983/84.

2.10 These facts clearly indicate that a variety of factors other than changes in crop and fertilizer prices have governed the past growth in fertilizer use. On the demand side, diffusion of fertilizer use at a growing number of

Table 2. Fertilizer consumption in Bangladesh, 1952/53 to 1983/84

Year	Consumption				N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Total	
	(1,000 metric tons)				
1952/53	1.8	-	-	1.8	1:0.00:0.00
1953/54	2.7	-	-	2.7	1:0.00:0.00
1954/55	3.6	-	-	3.6	1:0.00:0.00
1955/56	2.3	-	-	2.3	1:0.00:0.00
1956/57	5.2	-	-	5.2	1:0.00:0.00
1957/58	7.1	0.5	-	7.6	1:0.07:0.00
1958/59	8.0	0.5	-	8.5	1:0.06:0.00
1959/60	10.5	0.9	-	11.4	1:0.09:0.00
1961/62	19.3	3.0	0.5	22.8	1:0.16:0.03
1962/63	24.4	2.0	1.0	27.4	1:0.08:0.04
1963/64	36.6	11.1	2.0	49.7	1:0.30:0.05
1964/65	34.5	9.1	2.0	45.6	1:0.26:0.06
1965/66	38.9	9.8	2.3	51.0	1:0.25:0.06
1966/67	56.5	16.1	5.1	77.7	1:0.28:0.09
1967/68	71.1	22.5	7.0	100.6	1:0.32:0.10
1968/69	74.7	24.7	7.6	107.0	1:0.33:0.10
1969/70	91.8	30.6	9.2	131.6	1:0.33:0.10
1970/71	99.2	35.0	10.4	144.6	1:0.35:0.10
1971/72	79.3	28.1	8.5	115.9	1:0.35:0.11
1972/73	128.8	41.5	11.3	181.6	1:0.33:0.09
1973/74	122.3	43.8	11.2	177.3	1:0.36:0.09
1974/75	82.3	35.6	10.7	128.6	1:0.43:0.13
1975/76	145.8	51.4	13.2	210.4	1:0.35:0.09
1976/77	163.2	56.7	13.6	233.5	1:0.35:0.08
1977/78	223.2	89.4	43.3	355.9	1:0.40:0.19
1978/79	219.9	83.0	29.0	331.9	1:0.38:0.13
1979/80	250.5	96.4	53.8	400.7	1:0.38:0.21
1980/81	262.0	100.5	52.3	414.8	1:0.38:0.20
1981/82	242.5	97.4	56.9	396.8	1:0.40:0.23
1982/83	289.4	94.8	74.1	458.3	1:0.33:0.26
1983/84	342.6	163.4	37.5	543.5	1:0.48:0.11

Sources: 1952/53 to 1964/65 data are from Bangladesh Ministry of Agriculture, Bangladesh Agriculture in Statistics (Dhaka, 1974); 1965/66 to 1982/83 from Bangladesh Bureau of Statistics, Ministry of Planning, Statistical Pocket Book of Bangladesh, 1983 (Dhaka, 1984); and 1983/84 from Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1984.



locations accelerated growth of use in the Aus and Aman seasons, in addition to more intensive use during the Boro season. Irrigation development and the spread of high-yielding varieties (HYVs) clearly seem to have been important.

2.11 From the supply side, geographical expansion in the distribution system and fairly consistent growth in aggregate fertilizer supplies, as well as the changeover from the old to the new marketing system in the late 1970s, appear to be behind historical trends in the growth of fertilizer consumption. It is especially important to recognize all these forces explicitly while developing policies for sustained rapid growth in fertilizer consumption.

#### Consumption vis-a-vis Potential

2.12 In 1980, the International Fertilizer Development Centre (IFDC) estimated Bangladesh's agronomic potential for fertilizer use to be 1.70 million long tons of urea plus 1.46 million long tons of triple superphosphate or diammonium phosphate (TSP/DAP) and 0.82 million long tons of muriate of potash (MP), i.e. 3.98 million long tons of these fertilizer materials.<sup>2/</sup>

2.13 In terms of nutrients, the potential works out to a little over two million metric tons. On the basis of total cropped land, the potential amounts to about 150 kilograms of nutrients per hectare. This rate seems quite consistent with information in readily available literature on the response

---

<sup>2/</sup> The estimate was based on major soil classifications by thanas, cropped area in 1977/78, and fertilizer recommendations made in 1979 by the Bangladesh Agricultural Research Council in 1979. For details, see International Fertilizer Development Centre, Second Evaluation of the Bangladesh New Marketing System, (Muscle Shoals: IFDC, 1980).

function environment in Bangladesh:<sup>3/</sup>

The above estimate of the agronomic potential is not an unchanging number since it is based on cropped area, its distribution among various crops, and fertilizer recommendations. Notwithstanding possible overestimation in such an estimate, it provides a useful backdrop in the process of developing a perspective on the level and growth of actual fertilizer consumption. This is so because growth in fertilizer consumption occurs as a result of the conversion of this potential into actual fertilizer use.

2.14 Bangladesh's actual fertilizer consumption in 1983/84 was about 28 percent of the estimated potential -- 41 percent in the case of urea, 24 percent in the case of TSP/DAP, and only eight percent in the case of MP. These findings indicate that despite impressive growth in fertilizer consumption, Bangladesh has utilized less than 30 percent of the estimated agronomic potential of fertilizer use.

<sup>3/</sup> See, for instance, Kazi M. Badruddoza, "Experience in Farmers' Fields - Fertilizer Trials and Use in Bangladesh" in Proceedings: First Review Meeting, I.M.P.U.T.S. Project (Increasing Productivity Under Tight Supplies), edited by Saleem Ahmed and Muhammad Sadiq (Honolulu: East-West Center, 1976), pp.339-350. The article provides results of more than 10,000 fertilizer trials on farmers' fields conducted by the Soil Fertility and Soil Testing Institute between 1970 and 1975. The trials covered six crops (rice, wheat, sugarcane, potatoes, mustard, and groundnuts). Nearly 80 percent of the trials were on local and improved varieties of paddy grown in Aus, Aman and Boro seasons under irrigated as well as rainfed land sown with local varieties of paddy.

Badruddoza's results show that net returns to fertilizer use were maximized at nutrient application levels of around 160 pounds per acre on local varieties of paddy under rainfed conditions, 160 to 240 pounds per acre on improved varieties of rice and wheat, 310 to 375 pounds per acre on sugarcane and potatoes, and 120 to 135 pounds per acre on mustard and groundnuts.

The utilization of this potential in terms of different nutrients has proceeded at an uneven pace. This is clearly brought out by Table 2, which shows a time series for the consumption of the three nutrients, accompanied by the N:P:K ratio. The N:P:K ratio implied by the potential estimated by IFDC is roughly 1:0.75:0.55.

2.15 Thus, although there is substantial untapped potential for further rapid growth in nitrogen consumption, it would be imprudent for efforts to raise fertilizer use to focus indiscriminately on this nutrient alone. This would be the case from the economic, as well as the agronomic viewpoint, since additional crop production from nitrogen use depends on the use of other nutrients in specific soil groups and at high rates of nitrogen application.

The total fertilizer potential in a country is a summation of the potentials on different crops at various locations. Similarly, growth in the aggregate fertilizer consumption is an outcome of growth in use on various crops at different locations. Historical experiences of virtually all countries indicate that fertilizer use grows at different speeds on different crops. Even on the same crop, it grows at a different pace at different locations.<sup>4/</sup>

2.16 It is, therefore, important to review the past growth in fertilizer use from these angles, since it reveals composition of use at different points in time, factors behind it, and a profile of the potential which has remained untapped. Such an understanding could then be used to evolve policies for further sustained growth in fertilizer use.

---

<sup>4/</sup> For examples, see Guvant M. Desai, Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, IFPRI Research Report 31 (Washington, D.C.: International Food Policy Research Institute, 1982); and Guvant M. Desai and Gurdev Singh, Growth in Fertilizer Use in Districts of India: Performance and Policy Implications (Ahmedabad: Centre for Management in Agriculture, Indian Institute of Management, 1973).

### Share of Different Crops in Total Consumption

2.17 Fertilizer use in Bangladesh began on tea gardens in the early 1950s. It spread to other crops during the second half of the 1950s. Raisuddin Ahmed estimated, under a reasonable set of assumptions, that by 1960/61 rice had emerged with the dominant share of total fertilizer consumption (Table 3). Since Ahmed's estimates exclude application on tea plantations (about 2 to 10 thousand tons per year), the share of rice in the early 1960s could have been less than 70 percent. It grew to about 80 percent by the late 1960s. Thus acceleration in fertilizer consumption during the 1960s was due primarily to rapid growth of fertilizer use on rice.

2.18 Ahmed's estimates show that the relative shares of Aus and Aman paddy in total fertilizer consumption decreased between the early 1960s and the early 1970s. During the same period, the share of Boro paddy increased substantially. This was because the absolute amount of fertilizer used on Boro paddy increased by 22 times, while the quantity of fertilizer applied to Aus and Aman paddy rose by five to six fold. The faster growth of fertilizer use on Boro paddy was due to rapid growth in Boro paddy area (which, in turn, was principally due to irrigation development), diffusion of HYVs of rice in the Boro season, and a strategy of increasing rice production by emphasizing the Boro season.

2.19 None of these factors was the main driving force behind the five-to-six-fold growth in fertilizer consumption on Aus and Aman paddy, which, owing to larger initial area, was associated with a larger absolute increment of fertilizer use than was Boro paddy between 1960/61 and 1973/74. Instead, application growth on Aus and Aman paddy was mainly due to the beginning of a large conversion of untapped potential for fertilizer use into farmers' actual demand for fertilizers. This demand was met by the establishment of the East Pakistan

Table 3. Share of various crops in total fertilizer consumption in Bangladesh, 1960/61 to 1973/74

Year	Total Consumption (long tons of nutrients)	Rice			Total	Other Crops	Total
		Aus	aman	Boro			
1960/61	20,183	28.4	34.8	13.6	76.8	23.2	100
1961/62	19,718	26.3	35.1	13.6	75.0	25.0	100
1962/63	24,702	27.9	35.2	13.8	76.9	23.1	100
1963/64	47,924	<u>27.4</u>	34.8	14.3	76.5	23.5	100
1964/65	43,834	28.1	34.7	13.6	76.4	23.6	100
1965/66	50,289	27.1	35.6	14.0	77.7	22.3	100
1966/67	74,668	23.1	33.7	17.3	74.1	25.9	100
1967/68	97,598	23.8	34.9	19.8	78.5	21.5	100
1968/69	104,224	19.8	36.3	23.4	79.5	20.5	100
1969/70	129,626	19.3	34.1	25.3	79.7	20.3	100
1970/71	143,206	19.0	29.7	27.1	75.8	24.2	100
1971/72	114,904	20.0	26.5	29.1	75.6	24.4	100
1972/73	179,230	16.7	24.6	33.5	74.8	25.2	100
1973/74	172,695	18.6	23.4	36.3	78.3	21.7	100

Notes: Total consumption excludes application on tea gardens. Comparison of total consumption estimates here with those by FAO suggest that annual consumption on tea plantations must have varied between 2 and 10 thousand tons. Thus, the percentage shares of crops would actually be lower than those shown here.

Source: Developed from Appendix Tables 1.3(a) and 1.3(b) in Raisuddin Ahmed, Foodgrain Production in Bangladesh: An Analysis of Growth: Its Sources and Related Policies. (Dhaka: Bangladesh Agricultural Research Council, 1977).

Agricultural Development Corporation (now Bangladesh Agricultural Development Corporation) in 1962/63 and the consequent growth in the fertilizer distribution network. Following the introduction of Rapid Soil Fertility Survey Scheme in 1957 throughout East and West Pakistan, it became scientifically established that the response function environment of the 1950s provided sizeable untapped potential for fertilizer use.<sup>5/</sup> About 4,500 experiments were conducted between 1957 and 1962 in Bangladesh (then East Pakistan). About 90 percent of the experiments were on paddy and the remaining 10 percent were on wheat, sugar, potatoes, and mustard.

2.20 The experiments on paddy were conducted in all three seasons and were spread over six different soil tracts covering the entire country. Results of these experiments established that the response function environment on rice

---

5/ Efforts to generate scientific knowledge about response of crops to fertilizer use through experimentation and testing on farmers' fields were advocated as early as 1947 by Dr. M.O. Ghani, who was the Agricultural Chemist to the Government of East Bengal. These efforts, however, did not succeed until the mid-1950s, when the government of Pakistan asked the Food and Agriculture Organization of the United Nations for technical assistance in organizing fertilizer trials on cultivators' fields.

This led to the launching of the Rapid Soil Fertility Survey Scheme in 1957. Its aim was: 1) generating information on crop responses to fertilizer use; 2) encouraging farmers to take up fertilizer use through demonstrations; 3) making fertilizer recommendations; 4) obtaining information about the potential increase in production that could be achieved through fertilizer use -- information required for the formulation of agricultural development plans; and 5) specifying agricultural areas where fertilizers could be used to the best advantage. For details, see J.G. Vermaat, Report to the Government of Pakistan on Soil Fertility Investigation, Report No. 1887 (Rome: FAO, 1964), Project PAK/TE/LA.

was quite favorable. Even at 120 pounds of nutrients per acre the average response ratio was eight to nine pounds of paddy per pound of nutrient.

While the response of paddy to nitrogen was the highest (12.5 to 14.5 pounds of paddy per pound of nitrogen at 40 pounds of nitrogen per acre), it was also quite high for phosphate and potash (10 to 11 pounds of paddy per pound of phosphate, and seven to nine pounds of paddy per pound of potash at 40 pounds of these nutrients per acre).

Similarly, paddy yield response to fertilizer was confined neither to a single season (like Boro) nor to limited soil classifications. Since under the prevailing price environment, a unit of nutrient did not cost more than 1.66 units of paddy, fertilizer use was perceived to be quite profitable for farmers.<sup>6/</sup>

2.21 The explanations of acceleration in the growth in Bangladesh's fertilizer consumption during the 1960s usually focus on growth of fertilizer use on Boro paddy and emphasize factors like growth in Boro paddy area, development of irri-

---

<sup>6/</sup> Vermaat, who has reported the results of fertilizer trials conducted under the Rapid Soil Fertility Survey Scheme, estimated that there was scope to raise East Pakistan's rice production by 60 to 80 percent through fertilizer use alone. One may debate this estimate, as it involves generalization to all paddy land of average response ratios results. But from various details of the evidence generated by the scheme and comparable evidence from India, it is quite clear that the response function environment prevailing in Bangladesh in the late 1950s and the early 1960s offered sizeable scope for growth in fertilizer use.

There were two main reasons for this. First, fertilizer use had just begun: in the late 1950s, the use was less than two kilograms per hectare of total cropped land. Second, because of heavy subsidization of fertilizers, the price environment was extremely favourable. For example, a unit of nitrogen was about three times more expensive (in terms of rice) in West Bengal, India than in East Pakistan around 1960.

gation and diffusion on HYVs. All this is understandable given the dramatic growth in fertilizer use on Boro paddy. But such explanations bypass the forces which generated growth of fertilizer use on Aus and Aman paddy -- forces discussed above.

This could be misleading because it is clear from Ahmed's estimates in Table 3 that Boro paddy accounted for only 39 per cent of the increment in total fertilizer consumption between 1960/61 and 1973/74. Another 39 percent of the increment was due to growth in consumption on Aus and Aman paddy, and the remaining 22 percent was due to growth in fertilizer consumption on crops other than paddy.

Explicit recognition of the forces behind growth in fertilizer use on these crops could have led to policies to strengthen them and generate even faster growth, particularly on Aus and Aman paddy.

2.22 An indicative fertilizer consumption profile by crop can be developed for the 1979-81 period using: a) the proportions of crop areas fertilized and average rates of application based on survey findings available in IFDC-BARC reports; and b) official statistics relating to area under different crops.

Such a profile shows the following distribution of total fertilizer consumption in the early 1980s: rice - 81.5 percent, wheat - 7.4 percent, and the remaining crops - 11.1 percent. The 81.5 percent share of rice is comprised of 21.7 percent on Aus paddy, 39.8 percent on Aman paddy, and 20.0 percent on Boro paddy.

2.23 Two important conclusions emerge from the above findings. First, the share of rice in total fertilizer consumption increased marginally during the 1970s. This was so because it was already quite high (between 75 and 80 percent) by the late 1960s, as suggested by Ahmed's estimates. Second,



and more importantly, unlike trends during the 1960s, the relative shares of Aus and Aman paddy in total fertilizer consumption increased during the 1970s, and that of Boro paddy decreased. Of course, total consumption on paddy grown in each season (including Boro) increased substantially in absolute terms because of the vast growth in aggregate fertilizer consumption.

2.24 The above reversal of the relative importance of the three paddy crops in total fertilizer consumption in the 1970s is not surprising. Total paddy area was roughly distributed over the three seasons as 30 percent in Aus, 58 percent in Aman, and 12 percent in Boro. Obviously the dominance of Boro paddy, as the dynamic component among shares of total fertilizer consumption, could not long be sustained with such a small share of total paddy area, especially when fertilizer use on Aus and Aman paddy was already underway and gathering momentum during the 1960s.

2.25 Besides substantial area (and hence very large untapped fertilizer potential), what were the other factors which facilitated acceleration in the growth of fertilizer use on Aus and Aman paddy during the 1970s?

Available information suggests that the above question cannot be answered mainly in terms of HYVs since by 1981/82 only about 16 percent of the rice area in both these seasons was covered by HYVs. Against this, the findings available from the IFDC-BARC reports show that as much as 50 to 52 percent of the Aus and Aman rice area was fertilized. Nor does the explanation lie predominantly with irrigation development, inasmuch as rice during these two seasons is grown mainly on rainfed areas.

2.26 Thus, diffusion of local varieties and increases in rates of application emerge as important factors. These two processes were facilitated by rapid growth in aggregate

supply of fertilizers (financed to a considerable extent by foreign aid), the establishment of a widespread network for delivery of fertilizers to farmers, and continuation of the generally favourable price environment, despite upward adjustments in fertilizer prices.

2.27 The last point is brought out by Table 4, which presents a time-series of official prices for nitrogen and for procurement of rice and wheat in both Bangladesh and India for the 1967/68 to 1983/84 period. Readily available information also indicates that the fertilizer price environment in Bangladesh has been more favourable than in many other developing countries.

#### Proportions of Areas Fertilized and Rates of Application

2.28 Growth in total fertilizer consumption occurs as a result of increases in proportions of cropped area fertilized and upward movements in rates of application. It is, therefore, useful to examine past growth performance from these angles. However, firm estimates based on large sample surveys have not been available for Bangladesh until the late 1970s. Despite their limitations, the following findings for the early and mid-1970s seem worth noting before focusing on evidence available for recent years.

Assuming that farmers who use fertilizers apply 50 percent of the recommended rates, Ahmed estimated that during the 1971-74 period, only seven percent of Aus areas, four percent of Aman areas, and 18 percent of Boro paddy areas were fertilized. However, findings for 1966/77, based on a widespread but small-sample survey, indicate that actual rates might have been lower than 50 percent of recommended rates. Correspondingly, proportions of areas fertilized might have been higher than estimated by Ahmed.

Table 4. Ratios of official prices of nitrogen<sup>a/</sup> to procurement prices of rice and wheat in Bangladesh and India, 1967/68 to 1983/84

Year	Bangladesh		India	
	Rice <sup>b/</sup>	Wheat <sup>c/</sup>	Rice <sup>b/</sup>	Wheat <sup>c/</sup>
1967/68	0.78		2.19-2.72	1.93-2.82
1968/69	0.74		2.24-2.79	2.31-2.46
1969/70	0.74		2.37-3.06	2.70
1970/71	0.74		2.37-2.99	2.70
1971/72	0.58		2.32-2.87	2.64
1972/73	0.81		2.40-2.86	2.75
1973/74	1.05		2.18	2.78-3.00
1974/75	0.91		3.94	4.14
1975/76	0.91	1.51	3.64	3.83
1976/77	1.09	1.76	3.44	3.62
1977/78	0.98	1.63	2.93	3.06
1978/79	1.12	1.77	2.65	2.98
1979/80	1.32	2.27	2.22	2.74
1980/81	1.41	2.17	2.77	3.72
1981/82	1.41	2.12	2.97	3.93
1982/83	1.53	2.38	2.81	3.60
1983/84	n.a.d/e/	n.a.e/	2.24-2.37	3.09

a/ Nitrogen prices are based on urea for both countries.

b/ OPN/PPR, i.e., Official Price of Nitrogen/Procurement Price of Rice.

c/ OPN/PPW, i.e., Official Price of Nitrogen/Procurement Price of Wheat.

d/ Fertilizer prices were decontrolled throughout Bangladesh from April 1, 1983.

e/ The data are not available.

Sources: Based on information available from Raisuddin Ahmed, Foodgrain Production in Bangladesh: An Analysis of Growth: Its Sources and Related Policies (Dhaka: Bangladesh Agricultural Research Council, 1977); 1982 Statistical Yearbook of Bangladesh (Dhaka: Bangladesh Bureau of Statistics, 1983); Fertilizer Statistics, 1982/83 (New Delhi: Fertilizer Association of India, 1983); and Government of India, Economic Survey, 1983/84 (New Delhi, 1984).

2.29 In a sample of 20 clusters of 384 farms distributed over 10 out of 20 districts, Jabbar found that in 1976/77 about 70 percent of sample farmers had used fertilizer and 51 percent of the area under all crops was fertilized.<sup>7/</sup> With respect to proportion of area fertilized, the findings by crop were: HYV Boro paddy - 99 percent; local Boro paddy - 48 percent; Aus paddy - 42 percent; transplanted Aman paddy - 52 percent; jute - 33 percent; and tobacco - 60 percent.

These findings suggest two things: there was considerably higher diffusion of fertilizer use than estimated by Ahmed for 1971-74 and significant diffusion of fertilizer use on local varieties of paddy, and in Aus and Aman as well as the Boro seasons. On the other hand, Jabbar's findings reveal that even in 1976/77, the actual rates of application on fertilized land were considerably lower than Ahmed's assumption of 50 percent of the recommended rates for 1971-74. The actual rates were 30 to 37 percent of the recommended rates on Aus, transplanted Aman, and HYV Boro paddy.

2.30 If we divide total fertilizer consumption by the average rate of application found by Jabbar --- 100 kilograms of fertilizer materials (i.e., about 41 kilograms of nutrients) per hectare of fertilized land --- we arrive at an estimate of 5.24 million hectares of fertilized area for 1976/77. This is roughly 42 percent of Bangladesh's gross cropped area in that year. On the other hand, if we assume that the average rate on all fertilized land was higher than that revealed by Jabbar's small sample survey, then by 1976/77 gross cropped area fertilized would be less than 42 percent.

---

<sup>7/</sup> M.A. Jabbar, "Fertilizing Behaviour of a Sample of Bangladesh Farms, Bangladesh Journal of Agricultural Economics, 2 (no.2 1979): 57-71.

2.31 Much of the uncertainty about how many farmers were using fertilizers, what proportions of crop areas were fertilized, and at what rates, has been removed by the farm-level surveys conducted for the IFDC-BARC study on Agricultural Production, Fertilizer Use and Equity Considerations. These surveys were carried out in 10 cropping seasons from 1979 Aman to 1982 Aman. The survey locations (thanas) were spread all over the country, covering all districts except Patuakhali and Chittagong Hill Tracts. At each location about 120 farms were selected by stratified random sampling. The following paragraphs highlight some of the major findings of these surveys.

2.32 About 65 percent of Bangladesh's farmers were using fertilizers during the reference period of the surveys. About 50 percent of the planted acreage was fertilized. The average rate of application was 74 pounds of nutrients per acre of fertilized area.<sup>8/</sup>

---

8/ These national-level findings are reported on page 16 of IFDC, Bangladesh Policy Options for the Development of the Fertilizer Sector (Muscle Shoals: IFDC, 1982). One method of checking the reliability of the national-level figures is to multiply the survey-based estimates of a) the proportion of area fertilized, and b) the average rates of application per fertilized acre; by c) official estimates of total acreage; and thus arrive at an estimate of total fertilizer consumption.

There is, however, one difficulty. The definition of "planted area" is not available in the above report. If it is taken to mean "gross or total cropped area", then the total estimated consumption is about 35 percent higher than the official figure of total fertilizer consumption during the reference period of the surveys. On the other hand, if the term "planted area" is taken to mean "net cropped area", then the total estimated consumption is about 12 percent lower than the official figure for total fertilizer consumption.

After evaluating different alternatives, it seems reasonable to conclude that by around the late 1970s or early 1980s, nearly 50 percent of Bangladesh's gross cropped area was fertilized, at an average rate of 55 to 60 pounds of nutrients per fertilized acre.

2.33 On average, about 77 percent of Bangladesh wheat area, 57 percent of Boro paddy area, 51 percent of Aman paddy area, 51 percent of Aus paddy area, and 31 percent of jute area was fertilized (Table 5). The average rates of application in terms of fertilizer materials per fertilized acre under these crops were: wheat - 155 pounds; Boro paddy - 181 pounds; Aman paddy - 111 pounds, Aus paddy - 131 pounds; and jute - 81 pounds. In the case of all crops except wheat, the percentage of area fertilized was more than the percentage of area sown with HYVs, indicating that fertilizer use was not confined to HYVs.

2.34 On the other hand, virtually all area under wheat was sown with HYVs, but fertilizer use had spread to only 77 percent of the sown area. The diffusion of fertilizer use on wheat, however, was not confined to irrigated wheat, since only 33 percent of the area under the crop was irrigated. Against this, the fertilized area was 21 percentage points lower than the area irrigated in the case of Boro paddy, which indicates that fertilizer use had not yet spread to all irrigated area under Boro paddy.

2.35 The above findings relate to all sample locations taken together. Within these aggregates, there were vast variations with respect to both percentages of cropped area fertilized and average rates of application on the same crop among different locations (Tables 6 through 10 and Figures 3 through 7).

Nor were the changes (in these two determinants of fertilizer use) uniform across crops or locations. This is stressed because during the three-year survey period, fertilizer prices (in both nominal and relative terms) had increased. Despite this escalation in fertilizer prices, there were many locations where either the percentage area fertilized, or the average rate of application, or both, had increased. Thus, the con-

Table 5. Findings of IFDC-BARC surveys on percentage of area fertilized and average rates of application for Aus, Aman, and Boro paddy, wheat, and jute, 1979-82

Crop	Season	Year	Number of Sample Locations	Drop Area	Crop Area	Average Rate	Crop Area	
				in Sample	Ferti- lized		Irri- gated	Sown to HYVs
				(acres)	(per- cent)	(pounds of materials/ fertilized acre)	(percent)	
Paddy	Aus	1980	15	1,972	47.9	132	10.5	19.5
Paddy	Aus	1981	15	1,759	54.1	132	11.9	22.8
Paddy	Aus	1982	15	1,708	51.7	126	15.4	27.8
Weighted Average			15	1,813	51.1	131	12.5	23.1
Paddy	Aman	1979 <sup>a/</sup>	10	2,274	60.5	117	3.7	20.5
Paddy	Aman	1980	10	2,445	49.7	110	0.8	23.4
Paddy	Aman	1981	10	2,236	44.2	104	4.2	27.1
Weighted Average			10	2,318	51.4	111	2.8	23.6
Paddy	Boro	1979/80	8	573	59.5	185	75.0	58.4
Paddy	Boro	1980/81	8	467	57.5	145	79.2	55.7
Paddy	Boro	1981/82	8	488	52.1	213	80.2	50.8
Weighted Average			8	509	56.5	181	77.9	55.2
Wheat		1979/80	10	661	78.6	155	42.7	95.9
Wheat		1980/81	10	542	80.4	163	23.7	99.8
Wheat		1981/82	10	337	68.0	141	25.8	92.7
Weighted Average			10	513	76.9	155	32.3	96.6
Jute		1980	9	414	32.0	77	b/	0
Jute		1981	9	372	25.1	103	b/	0
Jute		1982	9	442	35.1	72	b/	b/
Weighted Average			9	409	30.9	81	b/	b/

a/ These data are occasionally criticized as less reliable, owing to survey quality control difficulties during the season during which the study was commenced.

b/ Less than 0.5 percent.

Source: This table is developed from the findings available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984). Only those locations for which findings are available for three years are considered.

Table 6. Fertilizer use by sample farmers on Aus paddy in Bangladesh, 1980-82

Location of Sample District, Thana	Aus Paddy 1980					Aus Paddy 1981					Aus Paddy 1982				
	Area (acres)	Irrig. gated (percent of area)	Under HYV	Ferti- lized	Rate <sup>a/</sup> (lbs/ acre)	Area (acres)	Irrig. gated (percent of area)	Under HYV	Ferti- lized	Rate (lbs/ acre)	Area (acres)	Irrig. gated (percent of area)	Under HYV	Ferti- lized	Rate (lbs/ acre)
Comilla - Chandina	153	0	8	74	195	130	7	23	96	160	127	7	22	96	88
Bogra - Nandigram	128	1	22	97	120	139	23	43	100	151	141	49	64	100	195
Dhaka - Kapasia	95	0	11	51	71	97	0	24	76	86	104	0	15	98	84
Khushtia - Mirpur	309	62	71	73	270	220	69	66	67	307	209	70	69	69	294
Tangail - Modhupur	150	0	4	69	86	97	0	10	55	91	56	0	4	6	83
Mymensingh - Phulpur	154	0	0	87	46	177	0	2	79	54	159	0	1	56	57
Noakhali - Sonagazi	21	0	29	100	109	127	0	45	99	118	130	0	47	98	123
Dinajpur - Chiribandar	205	0	15	14	64	159	0	13	13	54	175	4	24	12	83
Patna - Atgoria	151	6	12	15	110	114	0	8	45	84	91	26	28	42	155
Jessore - Jhikargacha	157	0	30	24	117	110	0	19	21	57	146	3	30	23	96
Barisal - Jhalakathi	98	0	0	1	200	56	0	1	5	120	75	0	9	23	157
Rangpur - Kurigram	144	3	4	37	78	166	10	12	21	105	98	3	5	25	60
Sylhet - Balagonj	44	0	0	1	100	52	0	1	2	300	50	0	2	2	150
Faridpur - Nagerkanda	33	0	0	2	100	34	0	0	0	0	65	0	0	3	67
Khulna - Fakirhat	130	0	0	24	125	81	0	0	18	214	82	0	1	46	57

a/ In terms of fertilizer materials per acre of fertilized land.

Source: Developed from information available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984).



Table 7. Fertilizer use by sample farmers on Boro paddy in Bangladesh, 1979/80 - 1981/82

Location of Sample District, Thana	Boro Paddy, 1979/80					Boro Paddy, 1980/81					Boro Paddy, 1981/82				
	Area	Irrigated	Under HYV	Fertilized	Rate <sup>a/</sup>	Area	Irrigated	Under HYV	Fertilized	Rate	Area	Irrigated	Under HYV	Fertilized	Rate
	(acres)	(percent of area)			(lbs/acre)	(acres)	(percent of area)			(lbs/acre)	(acres)	(percent of area)			(lbs/acre)
Chittagong - Ramu	104	55	100	97	309	95	82	98	99	287	98	97	100	100	262
Dhaka - Kapasia	77	36	36	38	229	66	26	34	32	58	66	4	18	14	157
Tangail - Modhupur	59	98	100	99	252	50	92	100	94	229	56	99	100	98	323
Nymonsingh - Phulpur	84	94	77	96	94	41	82	73	96	183	42	90	91	99	187
Jessore - Jhikargacha	27	68	100	98	330	27	100	100	100	327	40	97	100	100	313
Barisal - Jhalakathi	23	93	100	100	312	32	100	100	99	247	4	73	100	100	244
Sylhet - Salagonj	172	98	9	5	140	136	100	3	5	5	162	98	b/	4	175
Faridpur - Nagarbanda	27	0	51	50	306	20	0	8	8	12	20	10	0	0	0

a/ In terms of fertilizer materials per acre of fertilized land.

b/ Less than 0.5 percent.

Source: Developed from information available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984).

Table 8. Fertilizer use by sample farmers on Aman paddy in Bangladesh, 1979-81

Location of Sample District, Thana	Aman Paddy, 1979					Aman Paddy, 1980					Aman Paddy, 1981				
	Area (acres)	Irrigated (percent of area)	Under HYV	Fertilized	Rate <sup>a/</sup> (lbs/acre)	Area (acres)	Irrigated (percent of area)	Under HYV	Fertilized	Rate (lbs/acre)	Area (acres)	Irrigated (percent of area)	Under HYV	Fertilized	Rate (lbs/acre)
Chittagong - Ramu	353	0	68	78	127	361	0	68	52	133	347	0	76	24	98
Coaxilla - Chandina	169	2	15	73	160	116	0	14	21	157	136	0	12	76	79
Bogra - Nandigram	388	1	5	89	138	412	0	8	95	94	401	10	17	100	114
Tangail - Madhupur	178	10	45	78	142	176	0	33	77	112	152	0	28	71	94
Hoakhali - Sonagazi	134	0	35	97	180	136	0	30	94	93	141	0	38	98	110
Dinajpur - Chirirbandar	286	0	2	19	63	308	0	3	7	43	273	0	7	9	78
Pabna - Atghoria	237	15	17	69	141	217	5	20	59	171	189	13	34	79	167
Jessore - Jhikargacha	132	18	4	70	139	123	8	19	66	8	143	21	9	85	55
Barisal - Jhalakathi	227	0	1	22	68	212	0	0	2	100	155	0	0	13	62
Sylhet - Balagonj	170	0	1	1	30	147	0	0	4	75	161	0	1	3	167
Khulna - Fakirhat	-	-	-	-	-	237	0	43	45	198	138	0	47	49	171

22

a/ In terms of fertilizer materials (not nutrients) per acre of fertilized land.

Source: Developed from information available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984).

Table 9. Fertilizer use by sample farmers on wheat in Bangladesh, 1979/80 - 1981/82

Location of Sample District, Thana	Wheat 1979/80					Wheat, 1980/81					Wheat, 1981/82				
	Area (acres)	Irri- gated (percent of area)	Under HYV (percent of area)	Ferti- lized (percent of area)	Rate <sup>a/</sup> (lbs/ acre)	Area (acres)	Irri- gated (percent of area)	Under HYV (percent of area)	Ferti- lized (percent of area)	Rate (lbs/ acre)	Area (acres)	Irri- gated (percent of area)	Under HYV (percent of area)	Ferti- lized (percent of area)	Rate (lbs/ acre)
Comilla - Chandina	71	0	100	82	254	44	28	99	99	261	40	13	96	97	261
Bogra - Nandigram	11	47	100	100	229	26	79	100	100	258	10	90	97	97	288
Kushtia - Mirpur	52	34	100	97	206	76	0	100	98	135	48	67	100	65	177
Tangail - Modhupur	68	97	100	96	219	58	80	100	96	254	22	93	100	96	272
Mymensingh - Phulpur	25	24	51	92	97	21	7	100	83	78	4	20	100	73	81
Dinajpur - Chirirbandar	93	99	100	95	89	44	0	100	84	119	30	0	100	65	111
Pabna - Atghoria	123	38	100	82	173	89	14	100	89	181	47	24	100	72	147
Jessore - Jhikargacha	96	34	100	78	177	44	59	100	82	189	21	37	100	74	111
Rangpur - Kurigram	59	27	100	81	125	59	16	100	88	124	42	1	86	84	87
Faridpur - Nagarkanda	63	0	76	0	0	81	0	99	18	78	73	0	77	29	41

a/ In terms of fertilizer materials (not nutrients) per acre of fertilized land.

Sources: Developed from information available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984).

Table 10. Fertilizer use by sample farmers on jute in Bangladesh, 1980-82

Location of Sample District, Thana	Jute 1980					Jute 1980					Jute 1982				
	Area	Irri- gated	Under HYV	Ferti- lized	Rate <sup>a/</sup>	Area	Irri- gated	Under HYV	Ferti- lized	Rate	Area	Irri- gated	Under HYV	Ferti- lized	Rate
Comilla - Chandina	8	0	0	68	204	13	0	0	100	217	18	0	0	90	111
Kushtia - Mirpur	38	1	0	29	76	29	0	0	2	100	41	b/	0	8	125
Tangail - Modhupur	16	0	0	69	83	14	0	0	59	88	11	0	0	3	67
Mymensingh - Phulpur	35	0	0	89	52	22	0	0	48	90	29	0	0	50	44
Dinajpur - Chirirbandar	64	0	0	8	63	41	0	0	13	46	56	0	0	13	54
Pabna - Atghoria	40	0	0	48	125	32	0	0	50	146	42	b/	0	52	73
Jessore - Dhikargacha	63	0	0	12	125	78	0	0	29	93	110	0	0	31	100
Rangpur - Kurigram	76	0	0	18	56	61	0	0	16	44	54	0	0	11	36
Faridpur - Negarkonda	74	0	0	38	42	82	0	0	9	156	81	0	0	64	45

a/ In terms of fertilizer materials (not nutrients) per acre of fertilized land.

b/ Less than 0.5 percent.

Source: Developed from information available in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals: IFDC, 1982 and 1984).

Figure 3. Aus Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1980, 1981 and 1982

(%AF = Percent Crop Area Fertilized, AR = Average Rate of Application, Pounds of Materials per Fertilized Acre)

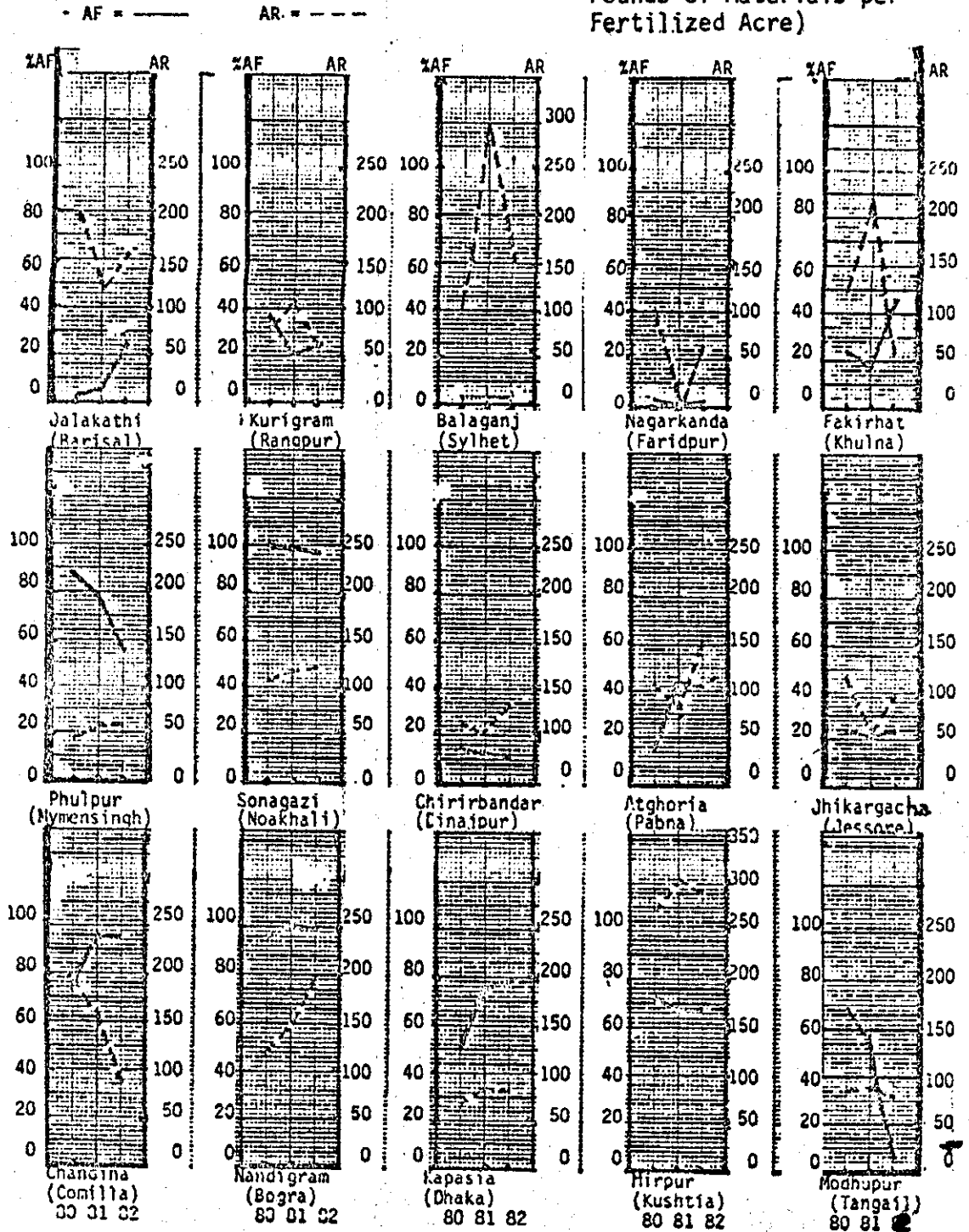


Figure 4. Aman Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979, 1980 and 1981

(%AF = Percent Crop Area Fertilized, AR = Average Rate of Application, Pounds of Materials per Fertilized Acre)

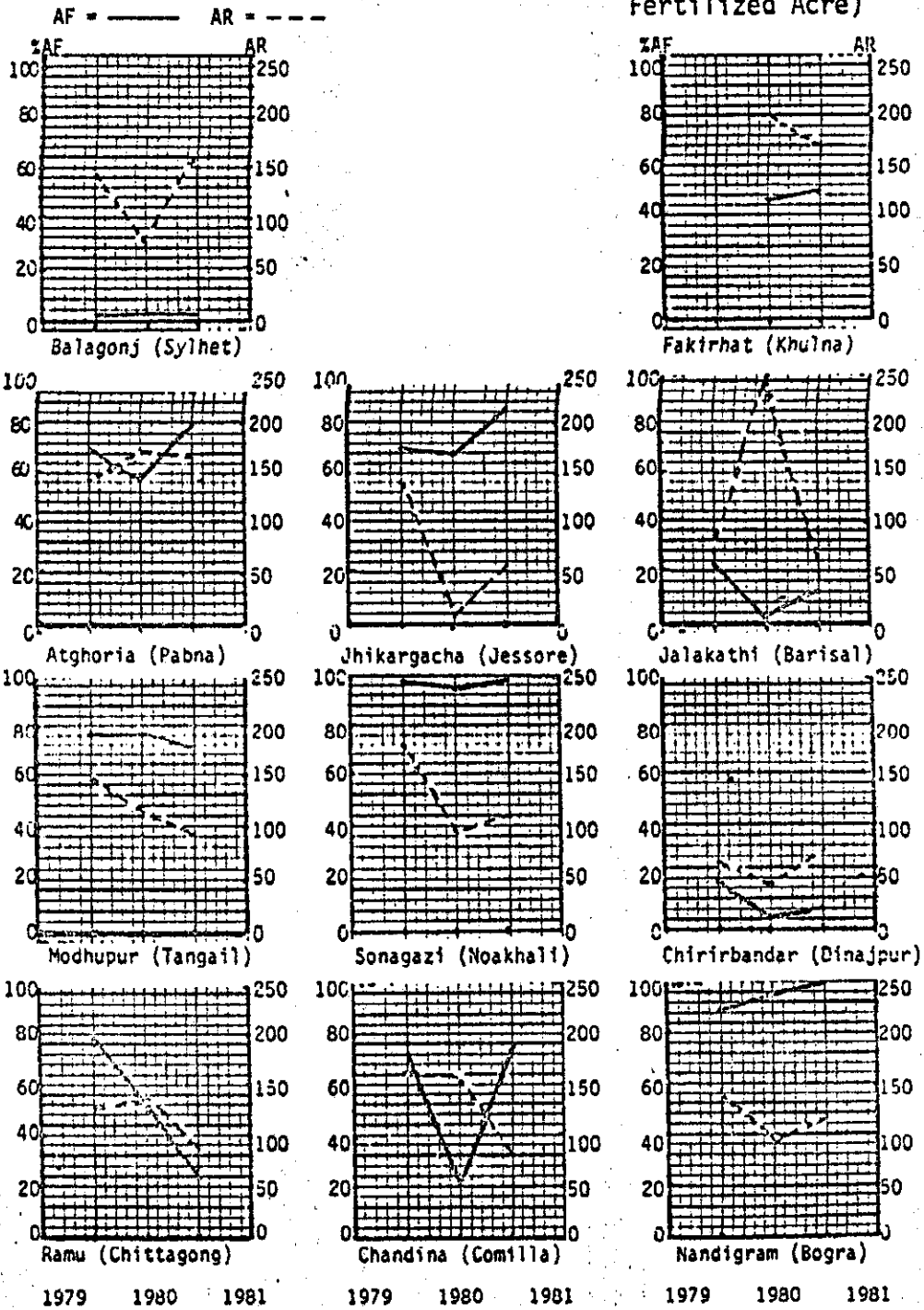


Figure 5. Boro Paddy, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979/80, 1980/81 and 1981/82

(%AF = Percent Crop Area Fertilized, AR = Average Rate of Application, Pounds of Materials per Fertilized Acre)

AF = ——— AR = - - - -

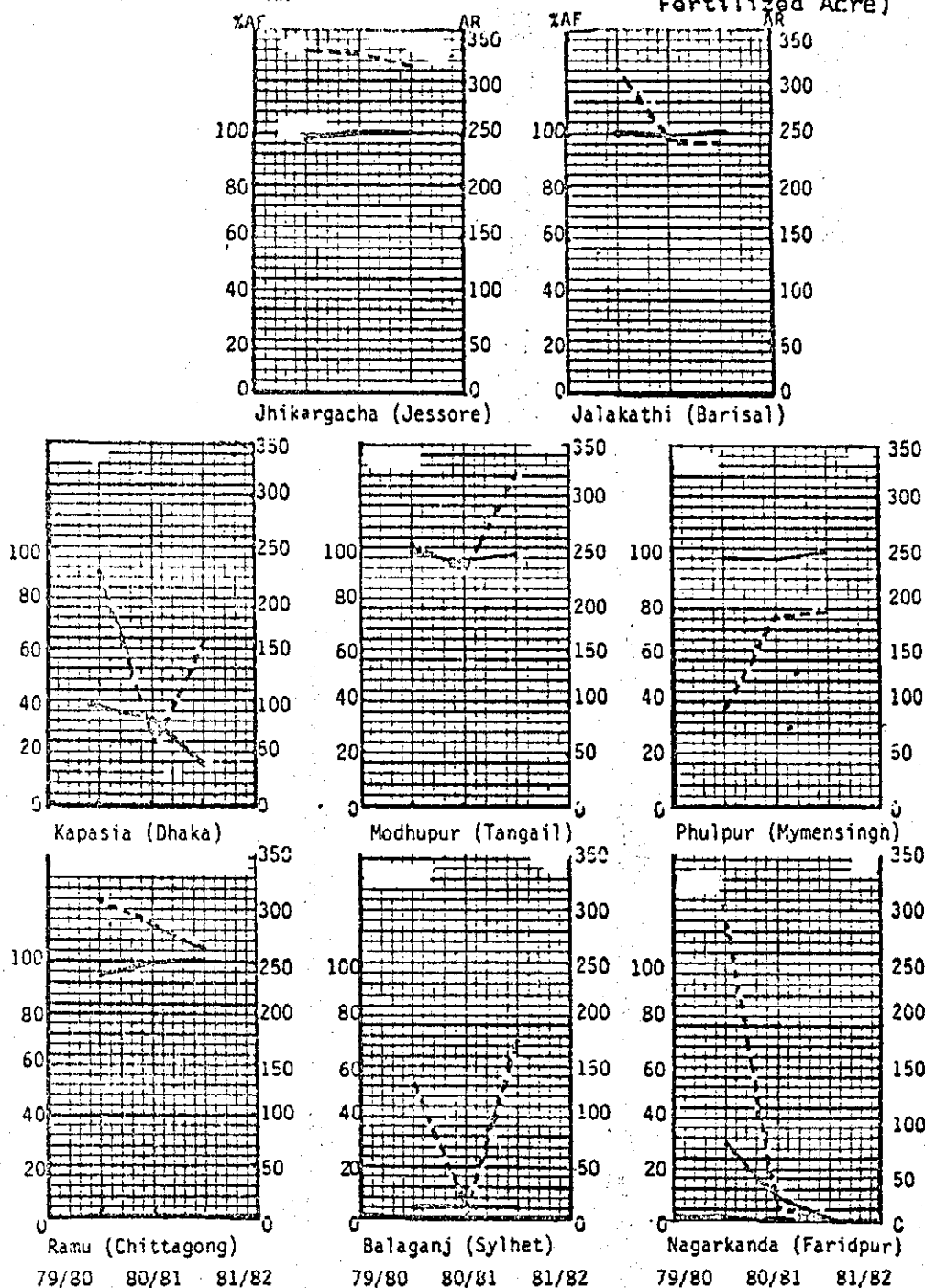


Figure 6. Wheat, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1979/80, 1980/81 and 1981/82

(% AF = Percent Crop Area Fertilized, AR = Average Rate of Application, Pounds of Materials per Fertilized Acre)

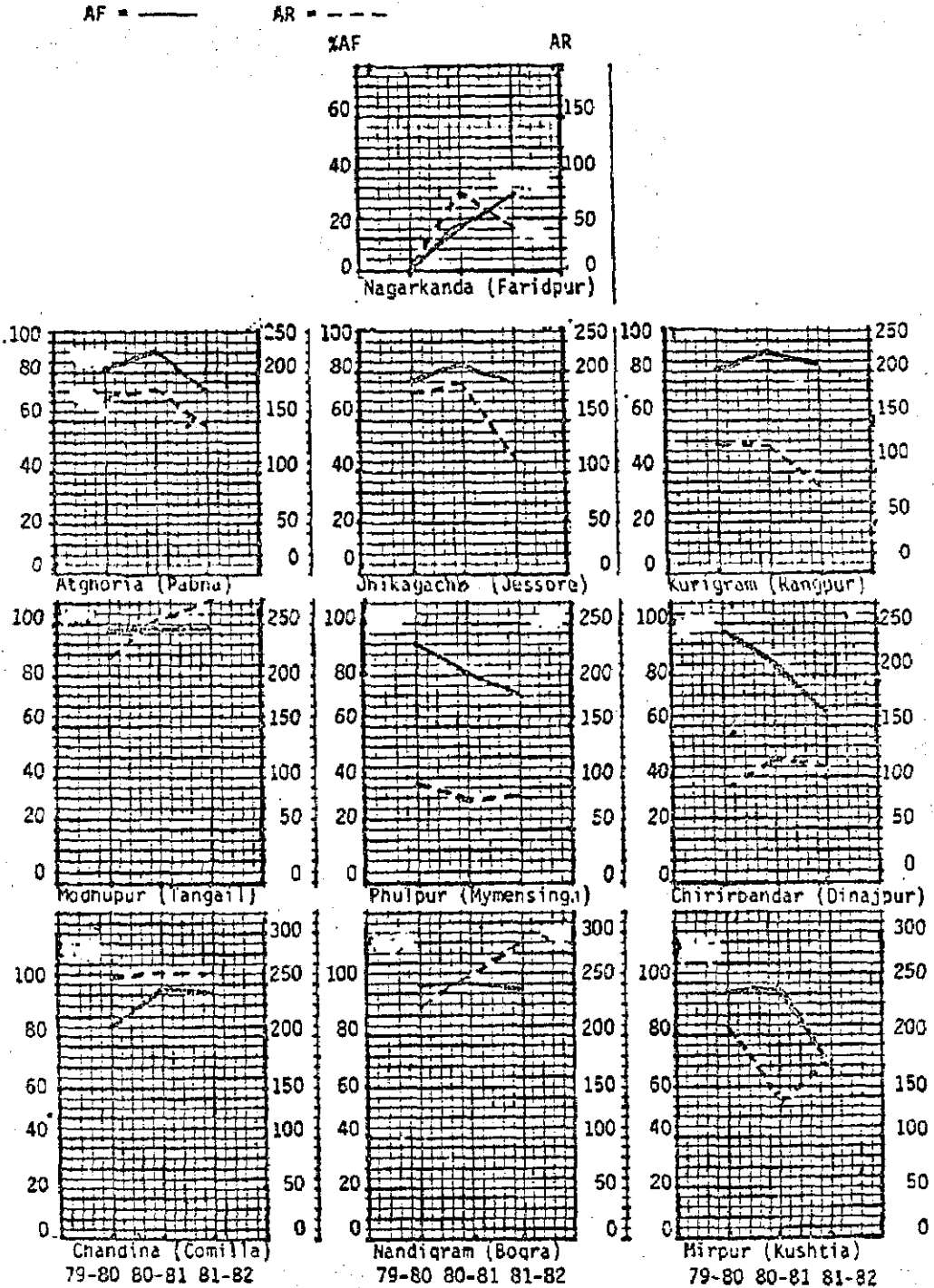
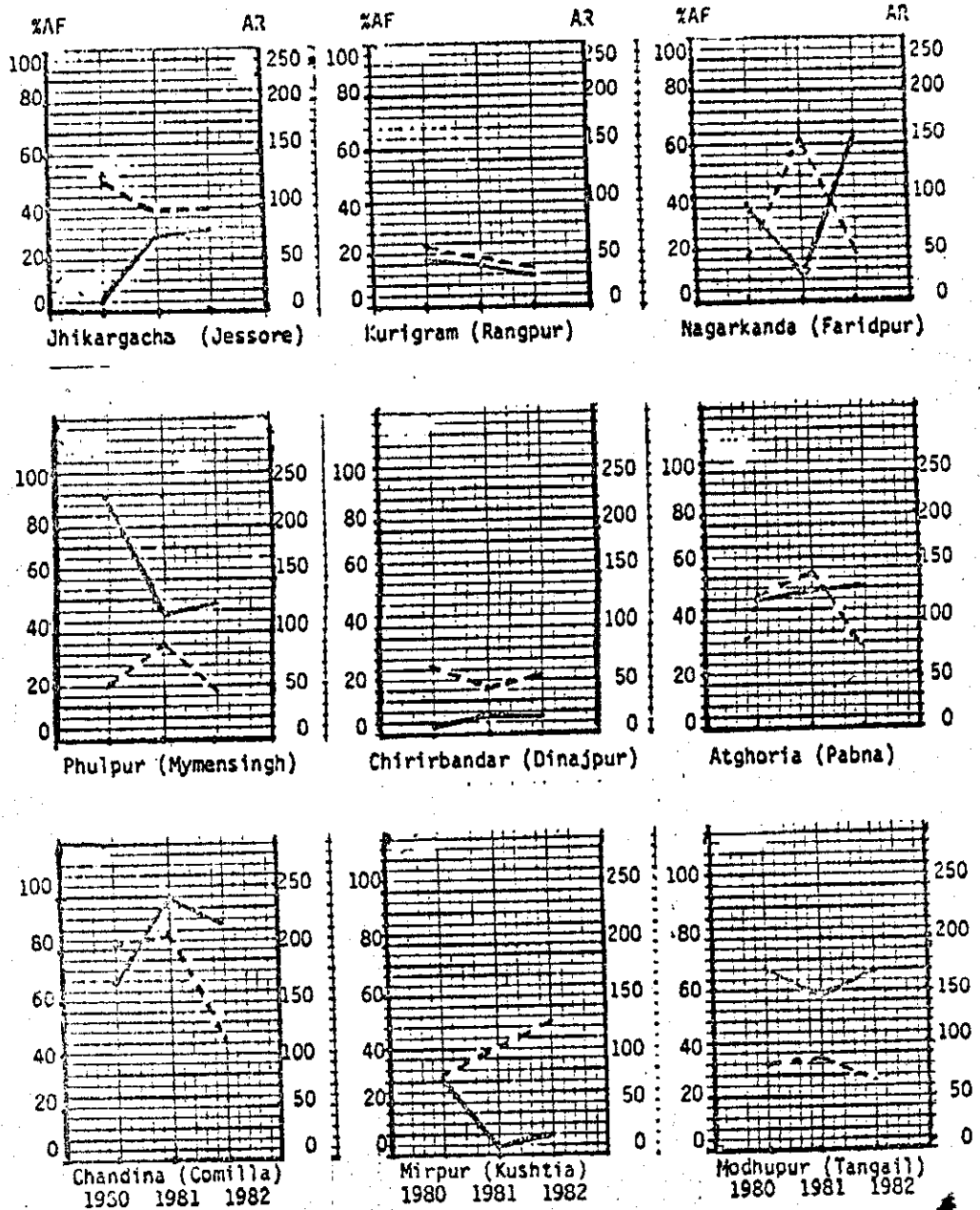




Figure 7. Jute, Percentage of Area Fertilized and Average Rates of Application by Sample Farmers at Different Locations in 1980, 1981 and 1982

(%AF = Percent Crop Area Fertilized, AR = Average Rate of Application, Pounds of Materials per Fertilized Acre)

AF = ——— AR = - - - -



clusion which emerges from these findings is that temporal changes in fertilizer use are governed by a variety of factors with different relative importance, at different locations, and for different crops.

2.36 Yet another conclusion suggested by the findings is that there were many locations where fertilizer use had spread to a much lesser extent than indicated by the aggregative findings. It is such locations which deserve attention in evolving policies for sustained rapid growth in Bangladesh's fertilizer consumption. This is especially important because some of the locations which have contributed to past growth in consumption, have already reached fairly high levels of both fertilizer diffusion and rates of application.

#### Growth Performance of Districts in Fertilizer Consumption

2.37 On the basis of 1983/84 fertilizer consumption per unit of land, 1969/70 to 1983/84 trends in fertilizer consumption, and the proportion of agronomic potential of fertilizer use tapped by 1983/84, the 21 districts of Bangladesh can roughly be divided into three groups:

Group A (5 districts) : Bogra, Kushtia, Dhaka, Comilla, and Chittagong

Group B (10 districts): Dinajpur, Rangpur, Jamalpur, Mymensingh, Kishoreganj, Rajshahi, Pabna, Tangail, Jessore, and Chittagong Hill Tracts

Group C (6 districts) : Sylhet, Faridpur, Khulna, Barisal, Noakhali, and Patuakhali

2.38 Table 11 shows district-wise 1983/84 levels of fertilizer consumption (in terms of kilograms of fertilizer materials per hectare of total cropped area) total consumption

Table 11. 1983/84 fertilizer use by Bangladesh district as proportion of potential, and changes in district-wise shares, 1969/70 - 1983/84

Districts	1983/84 consumption (kgs FM/ha. of TCA) <sup>a/</sup>	Percent Share in Total Consumption			Percent TCA 1981/82	1983/84 Consumption as Percent of Potential <sup>b/</sup>			
		1969/70	1978/79	1983/84		Urea	TSP/DAP	MP	Total
<b>Group A</b>									
Bogra	187	6.2	6.4	8.1	3.7	73	50	18	54
Kushdia	144	2.8	3.8	4.6	2.7	74	47	22	54
Dhaka	146	9.9	9.3	9.5	5.6	66	42	9	45
Comilla	136	12.1	15.3	10.7	6.6	65	41	15	45
Chittagong	166	16.3	9.7	6.6	3.4	75	20	6	41
Group A Average/Total	153	47.3	44.5	39.5	22.0	69	39	13	47
<b>Group B</b>									
Dinajpur	96	5.0	4.5	6.1	5.4	38	41	19	36
Rangpur	68	4.6	5.4	7.5	9.5	30	23	7	23
Mymensingh <sup>c/</sup> (Jamalpur)	86 (83)	10.9	12.3	11.7 (3.4)	12.7 (3.5)	40 (44)	16 (19)	4 (6)	24 (27)
(Mymensingh)	(65)			(3.3)	(4.4)	(34)	(10)	(2)	(17)
(Kishoreganj)	(88)		5.7	(5.0)	(4.8)	(49)	(21)	(5)	(30)
Rajshahi	101	4.8	5.6	7.7	6.5	42	29	8	30
Pabna	101	2.5	3.9	5.1	4.4	49	37	10	36
Tangail	100	2.2	3.7	4.3	3.7	52	31	11	36
Jessore	76	3.0	4.4	4.9	5.5	47	24	9	31
Chittagong Hill Tract	77	1.2	0.4	0.7	0.8	31	19	7	22
Group B Average/Total	80	34.2	40.2	48.0	48.5	47	11	8	28
<b>Group C</b>									
Sylhet	37	4.6	2.7	3.4	7.7	22	8	3	13
Faridpur	32	1.2	1.9	2.2	5.8	21	9	5	13
Khulna	36	2.8	1.3	1.8	4.1	21	8	2	13
Barisal	38	3.9	3.1	2.2	4.9	19	7	1	11
Noakhali	51	5.1	4.1	2.4	3.9	20	12	1	13
Patuakhali	14	0.9	1.0	0.5	2.9	9	2	0	5
Group C Average/Total	36	18.5	14.1	12.5	29.3	19	8	2	12
All Districts	86	100	98.8 <sup>d/</sup>	100	100	41	24	8	28

Note: FM refers to fertilizer materials. TCA refers to total cropped area.

- a/ Kilograms of fertilizer materials (FM) per hectare of total cropped area (TCA) of 1981/82, the latest year for which TCA data are readily available.
- b/ Based on IFDC estimates of agronomic potential. See the text and footnote to the text for details.
- c/ Includes Jamalpur and Kishoregonj.
- d/ District-wise data not available for 1.2 percent of total consumption.

Sources: Based on data available from World Bank, Bangladesh Food Policy Issues (Washington, D.C.: The World Bank, 1979); Bangladesh Bureau of Statistics, 1982 Statistical Yearbook of Bangladesh (Dhaka, 1983); Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1984; and Second Evaluation of the Bangladesh New Marketing System. (Muscle Shoals: IFDC, 1980).

in 1983/84 as a proportion of agronomic potential<sup>9/</sup>, the shares of each district in Bangladesh's fertilizer consumption in 1969/70, 1978/79, and 1983/84, and their shares in total cropped area in 1981/82. Figure 8 shows, 1969/70 to 1983/84 trends in fertilizer consumption.<sup>10/</sup> Several major points emerge from the table and the figure.

2.39 In 1983/84, Group A districts had the highest level of fertilizer consumption per hectare of total cropped area -- more than 135 kilograms of fertilizer materials. Group B districts came next with per hectare consumption between 65 and 101 kilograms of materials. Group C districts had the lowest level of consumption per hectare -- 14 to 51 kilograms of fertilizer materials.

2.40 Thus, there was very wide variation in the levels of fertilizer consumption among the various districts of Bangladesh. Two consequences of this variation were: a) geographical concentration of fertilizer use; and b) wide variation in the extent to which agronomic potential for fertilizer use was tapped in different districts.

---

9/ The district-wise estimates of agronomic potential of fertilizer used in Table 11 are the ones formulated by IFDC in 1980. They are based on major soil classifications by thanas, cropped area in 1977/78, and fertilizer recommendations made by BARC in 1979. Since these might have changed by 1983/84, estimates of potential tapped by 1983/84 must be considered no more than indicative.

10/ Since the objective of Figure 8 is to highlight trends in the total fertilizer consumption of various districts, total consumption in each district is divided by its total cropped area in one year (namely, 1977/78 for convenience in plotting trends). Therefore, 1983/84 levels of consumption shown in the figure differ marginally from those in Table 11. Mymensingh district in Figure 8 relates to Mymensingh, Jamalpur, and Kishoreganj districts, as separate time-series data are not available for each of the three.

Figure 8. Fertilizer Consumption Trends in Various Districts of Bangladesh.

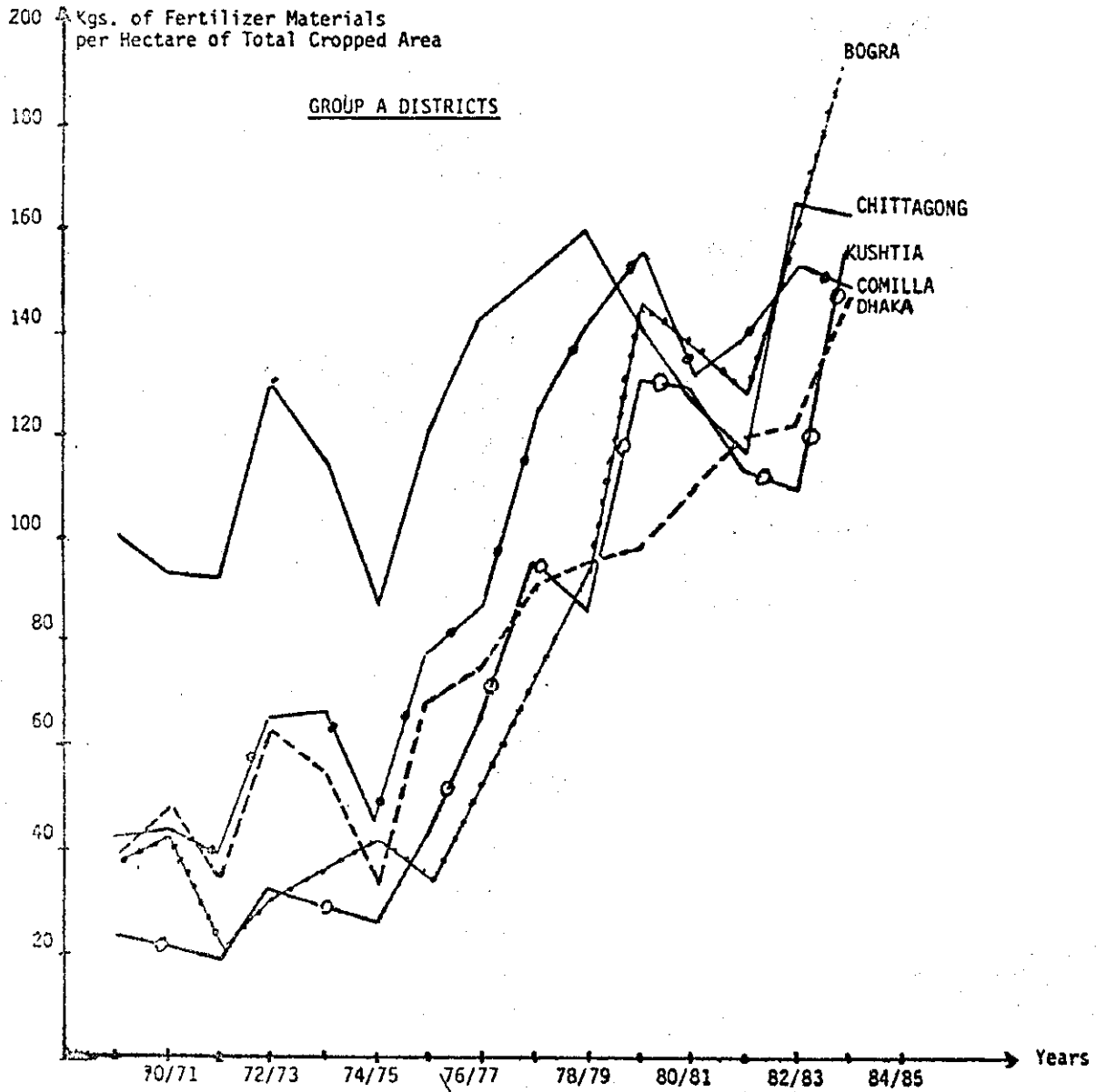


Figure 8. Continued

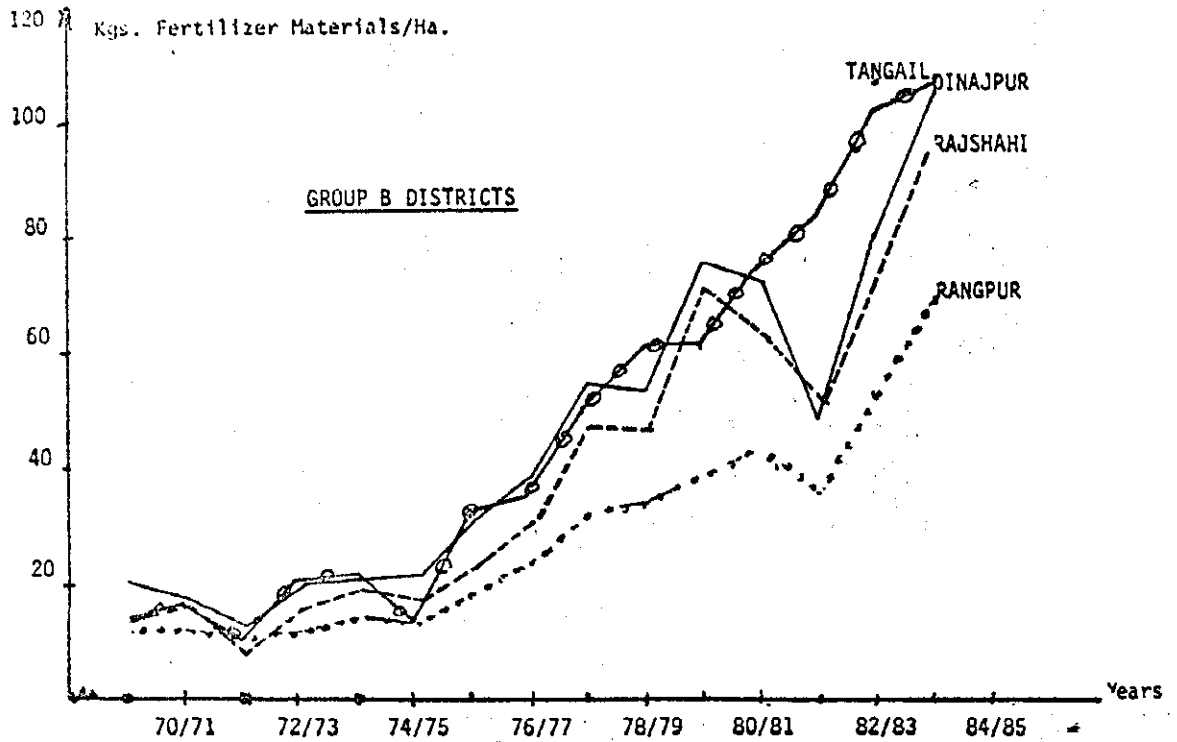
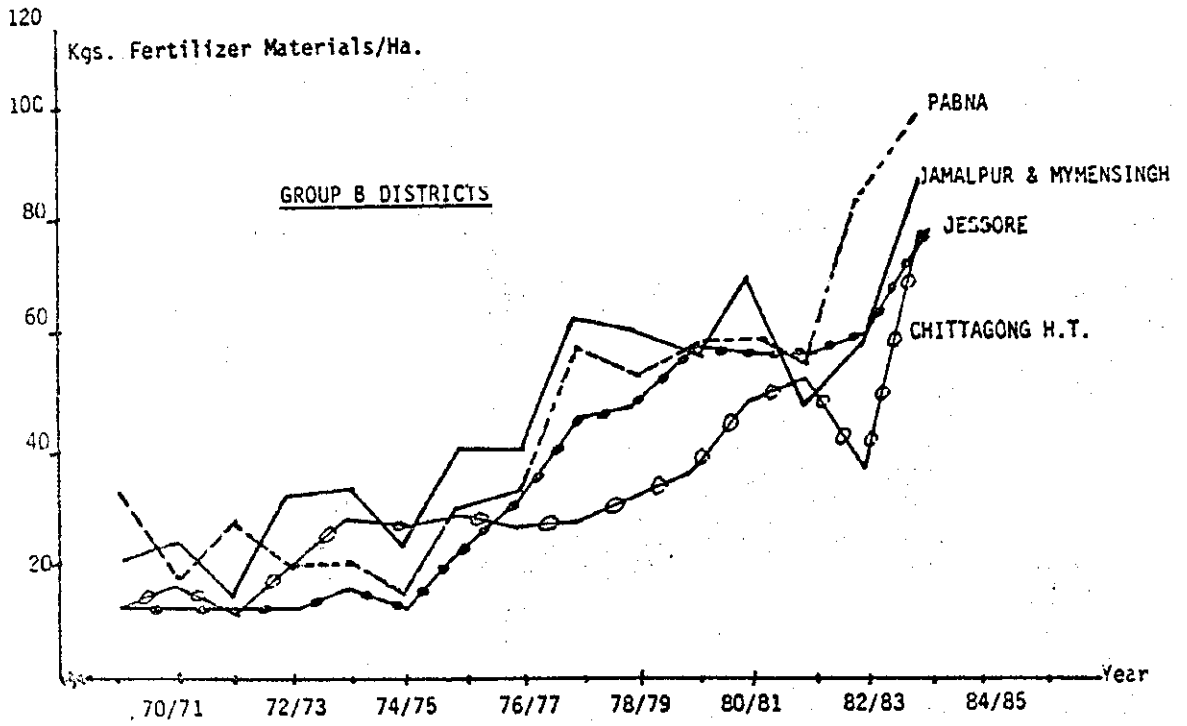
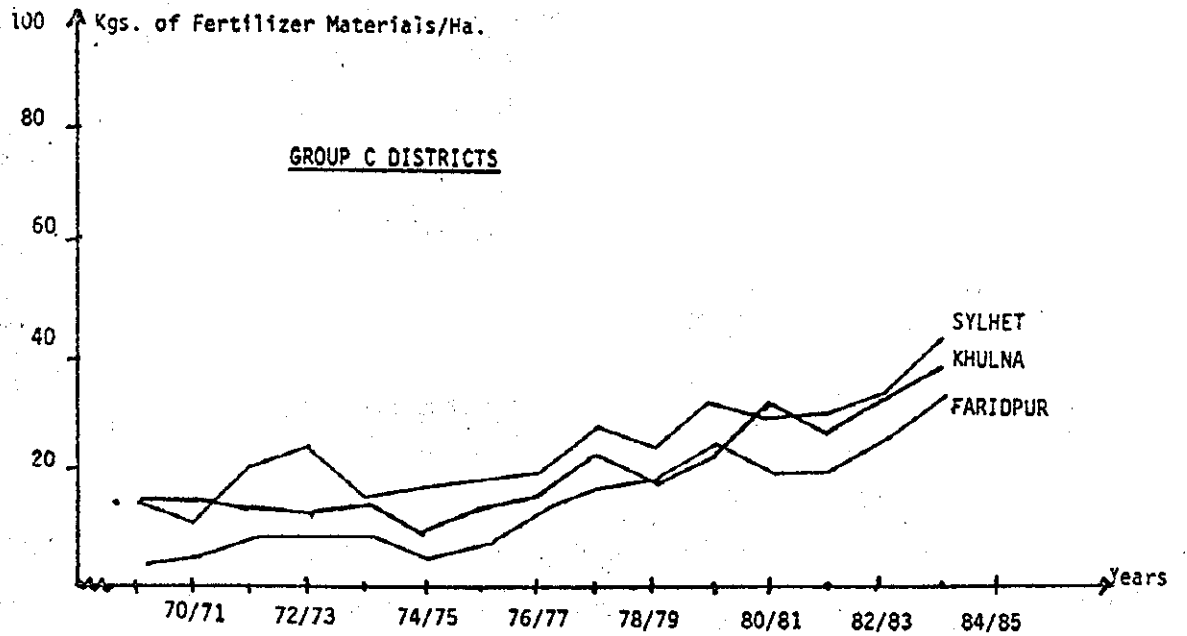
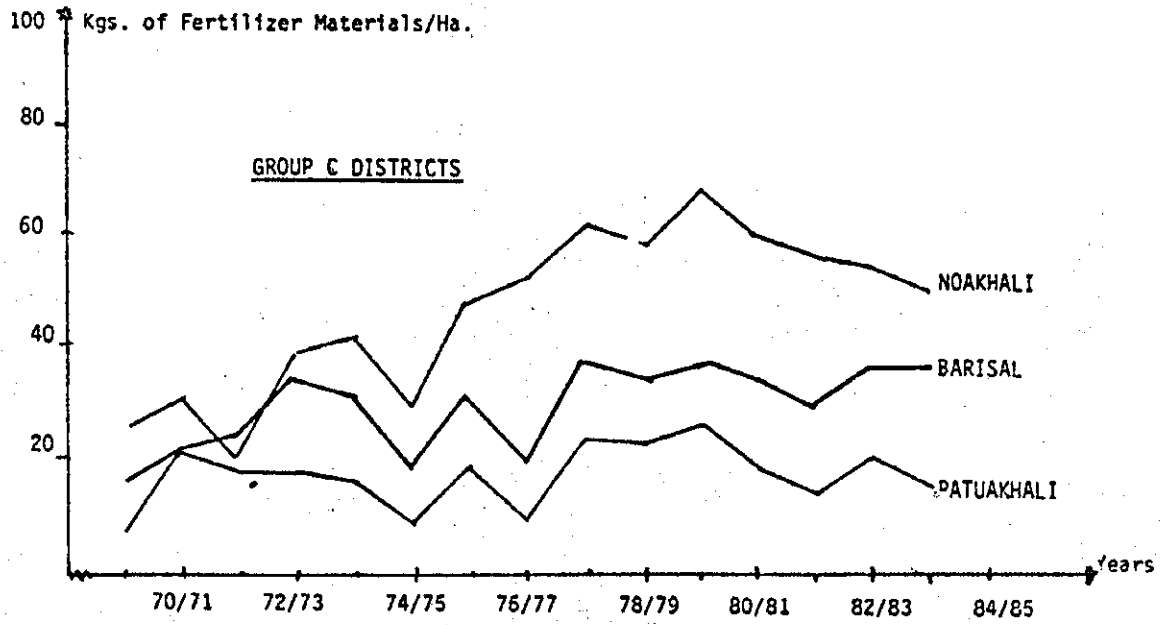


Figure 8. Continued





The five Group A districts with 22 percent of the country's total cropped area had a 40 percent share in total fertilizer consumption in 1983/84. At the other extreme, the six Group C districts had a share of only 13 percent in total fertilizer consumption even though they accounted for as much as 29 percent of the total cropped area. Only Group B districts had comparable shares in total fertilizer consumption and total cropped area (48 to 49 percent).

Between 1969/70 and 1983/84, the relative shares in total fertilizer consumption of both Group A and Group C districts declined -- that of Group A by 8 percentage points and that of Group C districts by six percentage points. Concurrently, the share of Group B districts increased by 14 percentage points. Even in more recent years, this trend in the relative shares of the three groups of districts has continued. Thus, for instance, between 1978/79 and 1983/84, the shares of Group A and Group C districts fell, whereas that of Group B districts has increased. Chittagong and Comilla in Group A, and Noakhali and Barisal in Group C, were mainly responsible for decline in the shares of the two groups. In Group B, all districts except Chittagong Hill Tracts had a higher share in 1983/84 than in 1969/70.

2.41 The decline in the relative shares of Chittagong and Comilla is understandable. Growth in fertilizer use gathered momentum in these districts earlier than in most other districts. Consequently, they accounted for as much as 28.4 percent of total fertilizer consumption despite encompassing only 10 percent of the total cropped area. With acceleration in consumption growth in other districts, the relative shares of Chittagong and Comilla were bound to decline. More so because the pace of growth in their consumption slackened, once they reached relatively high levels of consumption and high proportionate utilization of their agronomic potential. No such

explanation applies to the decline in shares of Noakhali and Barisal (the two Group C districts), since their consumption in 1983/84 was only 11 to 13 percent of their agronomic potential.

2.42 There are now substantial differences between the three groups of districts in terms of relative utilization of their agronomic potential for fertilizer use. In 1983/84, total fertilizer consumption in Group A is approximated at 47 percent of its agronomic potential. Among the five districts, the proportions varied between 41 and 54 percent. In the case of urea, it was as high as 69 percent, ranging from 65 to 75 percent among the five districts. In contrast, total fertilizer consumption in Group C districts was only 12 percent of its approximated agronomic potential, and in none of the districts did the proportion exceed 13 percent. Even in the case of urea, consumption was less than 20 percent of the estimated potential for the group as a whole, and did not surpass 22 percent in any district. Group B districts fell between Groups A and C with total consumption at 28 percent of the total potential, and total urea consumption at 47 percent of the estimated potential for urea use. Within Group B, utilization of the total potential ranged from 17 to 36 percent and that of urea from 30 to 52 percent.

2.43 One could question the dependability of the above findings by arguing that they are based on district-wise sales data: since there have been no restrictions on inter-district movements in recent years, these data may not accurately represent inter-district differences in consumption. There may be some validity to this criticism, but its importance is limited. Inter-district fertilizer movements were initiated only after the phased introduction of the New Marketing System, commencing in 1978. As Table 11 demonstrates, the 1978/79 pattern of fertilizer use was similar to the one described

above for 1983/84. Similarly, changes in the pattern of use between 1969/70 and 1978/79 appeared to be similar to those implied by the 1983/84 material. Most importantly, trends in fertilizer consumption of districts throughout the 1969/70 to 1983/84 period (Figure 8) lend support to the findings in Table 11.

2.44 The major features of the 1969/70 to 1981/82 trends in fertilizer consumption of various districts can be summarised as follows. First, for the period as a whole, consumption in Group A and B districts was rising far more rapidly than in Group C districts. In fact, in two out of the six districts of Group C (namely, Barisal and Patuakhali) it was hardly growing at all after the early 1970s. Second, there was virtually no growth or very slow growth in fertilizer use for a stretch of three to seven continuous years after the mid-1970s in Chittagong and Comilla (Group A districts) and in Pabna, Jessore, and Mymensingh (inclusive of Jamalpur and Kishoreganj). Third, there was a clear downward turn in the consumption trends of Noakhali and Patuakhali (Group C districts) after 1979/80. Finally, trends in total fertilizer consumption growth for Bangladesh were dominated by the consumption trends in Group A districts until the late 1970s. Subsequently, however, national growth trends have been increasingly dominated by acceleration among many of the Group B districts.

2.45 The above features of the geographical pattern of growth in Bangladesh's fertilizer consumption are not unique. The experiences of India, China, and even the U.S. have been fundamentally similar. This should be surprising since fertilizer consumption does not begin and gather similar momentum at all locations within a country at the same time. The variations in this pattern are governed by a variety of factors -- not all of which are those behind fertilizer response functions (e.g., irrigation levels, cropping patterns, and HYV diffusion).

2.46 Many other factors behind the supply and distribution side (e.g., fertilizer allocation policy, density of the distribution network, efficiency in the workings of the distribution system at different locations) plus the level of physical infrastructure development (e.g., road network and warehouse capacity) are also significant. The relative importance of these factors behind the geographical patterns of growth in fertilizer consumption, also differs among countries, and even among different locations within a country.

2.47 In order to evolve meaningful policies for long-term development of the fertilizer sector in Bangladesh, it is imperative to take account of the above findings. Two points seem particularly critical. First, concerted efforts are required to generate momentum in the consumption trends of Group C districts. These districts account for about 32 percent of the country's cultivable area and 29 percent of total cropped area. IFDC estimated their share of the nation's total agronomic potential for fertilizer use to be nearly 30 percent. Only one-eighth of this potential was tapped by 1983/84. Of still greater significance, there is no sign of acceleration in the consumption trends of most of these districts. Even with respect to urea (the most commonly used fertilizer), only 19 percent of the total potential of these districts was tapped by 1983/84. Clearly, long-term future growth in Bangladesh fertilizer consumption cannot be sustained while realization of such a large portion of the potential remains low and stagnant year after year.

2.48 It may appear that society's payoff on efforts to raise fertilizer use in these districts is generally lower than in Group A and Group B districts, because of lower ultimate potential in terms of crop responses to fertilizer use. Even if this were true, it is important to note that additional production from one unit of fertilizer use on unfertilized land in Group C

districts may be higher than can be achieved by further raising the high rates of application on already fertilized land in Group A districts. This is an empirical question and can be settled by examining appropriate data. Efforts required to generate momentum could take various directions, discussed in the next section.

2.49 The second point to recognize is that even in Group A and B districts, where total fertilizer consumption has been increasing rapidly, the pace of growth in nitrogen use has been much higher than that of phosphates; and growth in the use of potash has been most sluggish. Thus in some of these districts where as much as 60 to 70 percent of the agronomic potential for nitrogen has been utilized, the proportion of phosphate potential utilized is considerably less, and that of potash is negligible. In these districts, further growth in even nitrogen use, especially through raising rates of application on fertilized land, would be dependent on generating acceleration in application of phosphates and potash.

2.50 This growth, in turn, may be more dependent on generating location-specific knowledge about the different nutrient requirements, and utilizing this knowledge to convince farmers of higher returns available from appropriate changes in fertilizer practices, rather than on price subsidies for phosphate and potash fertilizers.

2.51 If subsidies, by themselves, could accomplish this task, then Chittagong fertilizer use would be characterized by a more balanced consumption pattern. In 1983/84, urea consumption in the district was 75 percent of its potential, while the proportion for TSP/DAP was only 20 percent, and that of MP was just six percent.

### III. POLICIES FOR LONG-TERM GROWTH IN FERTILIZER USE

3.1 Policies for long-term growth in fertilizer use should be based on a critical appreciation of the various features of, and the major forces behind, the past pace and pattern of growth in fertilizer consumption. This is especially important if these policies are to generate sustained rapid growth in fertilizer use which is both profitable to farmers and manageable for the society at large.

Before turning to these policies, two preliminary discussions may be useful. The first concerns major strengths and problem areas in Bangladesh revealed by the overview, and the second relates to the appropriate framework for policy discussions.

#### Major Strengths and Problem Areas

3.2 Both fertilizer consumption per unit of land and growth in aggregate consumption have been higher in Bangladesh than in a majority of the developing countries. What makes Bangladesh's performance particularly impressive is that in less than three decades: a) fertilizer use has been adopted by nearly two-thirds of the nation's farmers (a large majority of whom are poor and operate very small farms; b) use has spread to about half of the gross cultivated area throughout the country (most of which is unirrigated); and c) fertilizer use on even local varieties of the dominant food crop is not uncommon. Few countries can claim such a record.

The above features are considered "strengths" because they indicate widespread understanding among farmers about the general benefits of fertilizer use under various farming circumstances typical of Bangladesh. Another cause for optimism is that unusual record indicates the existence of operating processes and systems capable of achieving such fortuitous results.

3.3 Yet another positive feature is that considerable agronomic potential of fertilizer use remains untapped. (Even if one discounts by 50 percent the estimate of this potential formulated by IFDC, Bangladesh would have tapped only about half of the discounted potential.) This indicates that even without dramatic breakthroughs in crop varieties or growth in irrigation, substantial further growth in fertilizer consumption may be possible. Growth in fertilizer use during 1982/83 and also during 1984/85, despite adverse changes in the price environment, supports such a position.

3.4 At the same time, the bulk of past growth in fertilizer consumption resulted from tapping those parts of the total potential on which farmers' returns to fertilizer use were relatively high, because of superior and/or rapidly improving response functions. Similarly, the bulk of past growth has been at locations where it was relatively easy to facilitate because of relatively greater development of the physical and institutional infrastructure relevant to growth in fertilizer use. While agronomic potential at such locations is by no means exhausted, the task of further growth in consumption may not be as easy as in the past. High marginal returns to fertilizer use through increases in rates of application depend on increasing sophistication in fertilizer use -- especially in terms of location-specific research and extension.

3.5 It is also clear from the district-wise findings that sustained rapid growth in future fertilizer use also calls for generating momentum in the consumption trends of Group C districts. Policies required for this effort are apt to be quite different from those required to maintain the momentum of growth in consumption in Group A and Group B districts.

### A Framework to Discuss Policy Requirements

3.6 Policy requirements for long-term rapid growth in Bangladesh fertilizer consumption can be discussed in two different contexts. One typical context would be to view growth in fertilizer use as being driven by growth in farmers' fertilizer demand, and consider the latter as being determined by changes in variables which affect farmers' returns on fertilizer use. This approach underlies many empirical studies in which factors governing growth in fertilizer consumption are identified by considering fertilizer consumption as a function of such agro-economic variables as irrigation, area sown to fertilizer-responsive crop varieties, cropping patterns, and prices of crops as well as fertilizers. The estimated growth parameters of different explanatory variables are then used to draw policy conclusions.

3.7 In the context of sustained rapid growth in Bangladesh's fertilizer consumption, the above approach leads to such questions as: Changes of what magnitudes are required every year in the variables shifting fertilizer response functions upwards, or in the ratios of fertilizer to crop prices, to increase fertilizer consumption by the desired magnitude? Which policies will produce these changes? Are these policies sustainable?

The above approach and the questions suggested by it constrain the discussion of policies required to generate the desired rate of growth in fertilizer consumption. This is mainly because growth in fertilizer use is treated as causally determined by changes in variables behind fertilizer response functions and by changes in prices of fertilizers and crops to the exclusion of all other dynamic elements. It is senseless to downplay the importance of these variables. But it is one thing to recognize their importance and quite another to maintain that under all circumstances changes in these variables



are necessary to generate growth in fertilizer use. Both a priori reasoning and historical experiences of many countries clearly suggest that such an interpretation of growth in fertilizer consumption is extremely mechanistic and could lead to imprudent (if not altogether unrealistic) price policy prescriptions, if possibilities of continuous upward shifts in response functions are limited.

3.8 Yet another limitation of the above approach is that it neither explains many features of the past pace and pattern of fertilizer consumption growth in Bangladesh, nor does it provide a useful context for addressing the task of tapping the unutilized fertilizer potential through institutional development and policy formation.

A more comprehensive context for discussing policy requirements for long-term growth would involve recognition of the important role both of variables which affect economic potential for fertilizer use, and of those which affect realization of that potential. The economic potential for fertilizer use in a country is determined by fertilizer response functions, prices of crops, and costs of fertilizer: that is, the agro-economic variables which determine profitability of fertilizer use. Actual fertilizer use is the combined result of the conversion of this potential into farmers' demand for fertilizer, and of satisfaction of this demand by successful operation of fertilizer supply and distribution systems. Thus, besides agro-economic variables, three types of processes and interactions among them influence actual fertilizer use:

- a) the processes which convert the potential into farmers' fertilizer demand by generating knowledge about fertilizer response functions, by spreading this knowledge among farmers, and by enabling them to purchase fertilizer through adequate credit provision;

- b) the processes which establish the fertilizer distribution system, and govern its operation in making fertilizers available to farmers at geographically dispersed locations;
- c) the processes which determine aggregate supply of fertilizers through domestic production and imports.

3.9 These three processes are governed by the workings of particular sub-systems. These include agricultural research and extension, agricultural credit, fertilizer distribution, the domestic fertilizer industry, and the sub-system involved in fertilizer imports. In these terms, the actual level of fertilizer consumption is determined not only by the agro-economic variables, but also by the level of development and operation of all the above sub-systems.

Even farmers' decisions about whether, on which crops, and at what rates to use fertilizers, are influenced by both agro-economic variables and the operation of agricultural research, extension, and credit systems. Rationality of farmers does not mean that they are omniscient. Even rational farmers need knowledge about the responses of crops to fertilizer use -- knowledge generated by the research system and delivered by the extension system. In addition, supply of sufficient credit is necessary to convert fertilizer response functions into farmers' effective demand schedules for fertilizers. Even this is not enough. Actual use of fertilizers would still depend on whether adequate fertilizers are available to farmers at the right place and time -- something which depends on the level of development and efficiency in the operation of the fertilizer distribution and supply systems.

3.10 The above more comprehensive context appears appropriate to discuss policy requirements for long-term growth in Bangladesh fertilizer consumption. It does not focus

exclusively on variables like irrigation, HYVs, and the agro-climatic environment, which determine responses of crops to fertilizer use, nor on prices of crops and fertilizers, variables which determine potential for, as well as returns to fertilizer use. Nor does it bypass these variables and their influence on pace and pattern of growth in fertilizer use. But it also allows for processes and systems which convert the potential into farmers' effective demand for fertilizers, as well as those which meet this demand at geographically dispersed locations, thus converting fertilizer potential into actual fertilizer use. In this manner, the approach facilitates meaningful examination of all major elements which have a bearing not only on sustained rapid growth in fertilizer use, but also on healthy development of the entire fertilizer system.

#### Important Policy Issues and Suggestions

3.11 To use the above approach empirically, it is necessary to perform research on the operation of all-systems which affect growth in fertilizer use, as well as on interactions between these sub-systems, in order to identify deficiencies and conflict, and work out policies to eliminate them. Execution of such a comprehensive research program has not been undertaken. Thus, what follows is not a detailed prescription of policies. It is a set of policy issues and suggestions which appear relevant on the basis of an examination of readily available information and data are examined.

1. For continuous growth in farmers' demand for fertilizers, it is just as important to focus the efforts on the conversion of the unutilized potential as on continuously raising the potential. In these efforts, agricultural research and extension systems are obviously the critical agencies. They need to be strengthened to undertake efforts in the following directions.

2. In order to generate additional fertilizer demand through conversion of the utilized potential, the first step would be to develop a profile of this potential (e.g., by crops, seasons, locations, agroclimatic conditions, etc.,) and examine its economic viability from farmers' viewpoints. Such an exercise is required for all three nutrients among Group C and Group B districts, and for phosphates and potash among Group A districts. The availability of data from fertilizer trials, experiments, and soil fertility investigations carried out so far may be reasonably adequate, at least for purposes of beginning this exercise. These data must be deliberately analyzed at disaggregated levels to identify situations in which responses of crops to different nutrients make their application profitable to farmers in various types of localities under existing and anticipated price environments.

3. From the accumulated agricultural research, critical aspects of fertilizer practices which influence responses of crops to fertilizers must be identified (e.g., details of timing and placement, complementarity between different nutrients, micro-nutrient and soil additive needs, and other aspects of agronomic practices). This knowledge should also be generated for disaggregated locations because of the highly varied agro-climatic environment of Bangladesh. It should then be utilized to develop location-specific action strategies to shift response functions upwards. The importance of developing such location-specific strategies cannot be overemphasized. This route differs from exclusive concentration upon the introduction of new crop varieties. The importance of agronomic research to raise productivity and efficiency of fertilizer use is enhanced, and not reduced, when HYVs are introduced, as the experience of the last 15 years clearly reveals. What is stressed here is that such agronomic research-based strategies might also improve responses of existing

varieties to fertilizer use, and thus do not make upward shifts in response functions exclusively dependent on adoption of HYVs and water control development.

4. In a long-term perspective, however, there are no alternatives to such technological changes as new crop varieties and development of water control potential in order to shift response functions upwards. Thus, there cannot be two opinions about strengthening efforts in these usual directions.

5. Location-specific strategies to maintain momentum of growth in fertilizer consumption in Group A and B districts and to generate acceleration in the growth in Group C districts need to be based on knowledge about the response function environment mentioned above. The other important plank of this strategy should be to deliver this knowledge to farmers in a sustained and effective manner. The most appropriate agency for this is the agricultural extension system. While other entities, like the fertilizer dealers, may be encouraged to participate in delivering such knowledge to farmers, it must be recognized that they cannot be an effective substitute for the extension system. If experience in other developing countries is any guide and applicable to Bangladesh, then much remains to be done to improve the efficacy of the extension system in providing adequate scientific knowledge to farmers about fertilizer practices. The system must have done an impressive task in spreading awareness of fertilizers among farmers. Current and future requirements entail provision of relevant scientific knowledge about details of fertilizer practices. This requires a much closer and decentralized interface between agricultural research and extension systems - something which is lacking in most developing countries, including perhaps Bangladesh. Development of this interface should proceed as rapidly as possible. Introduction of the T & V System may have made a beginning in this direction, but it needs to be examined whether the current manner of operation is adequately serving this objective.

6. Inadequate provision of institutional credit does not seem to have been a major constraint in the past growth of fertilizer consumption in Bangladesh. Perhaps this was so because of very high fertilizer subsidies and relatively low rates of application, both of which reduce cash requirements of fertilizer use. In the future, growth of fertilizer demand will be more dependent on the flow of institutional credit to farmers because: a) rates of application on fertilized land (especially in Group A districts) are quite high; b) fertilizer subsidy is being phased out; c) farmers who are not yet using fertilizer may have more severe liquidity constraints; and d) initial returns to fertilizer use on land which is not yet fertilized are likely to be lower than the land already fertilized. Thus, there seems to be a clear need to expand flows of institutional credit to farmers in order to sustain rapid growth in fertilizer demand. Efforts in these directions, however, need to be geographically coordinated with efforts to generate additional fertilizer demand mentioned in the previous paragraphs. Similarly, they also need to be coordinated at local levels with fertilizer delivery systems. In the absence of such coordination, the budgetary burden of fertilizer subsidies would only be replaced by that of rural loan defaults.

7. All available information clearly shows that Bangladesh has one of the most widespread and dense networks of fertilizer distribution systems among developing countries. This remains so even if only "active" retailers and wholesalers are considered. Thus, for instance, for a comparable size of any Indian state, Bangladesh has four to five times the number of fertilizer outlets. Despite this, a variety of literature has indicated that timely availability of adequate fertilizers to many farmers in various localities has not ceased to be a problem.

Although no comprehensive study has been made of this difficulty, discussions with a few dealers and PDP officials suggest that supplies are sometimes inadequate at the time when dealers get fertilizers from BADC outlets at thana and district levels. It appears that this, in turn, may be largely due to dealers getting fertilizers at the latest possible moment in order to minimize their cost of carrying inventories. Efforts are being made to remedy this inconsistency through providing incentives for dealers to pick up fertilizers during off-seasons. However, to date the stocking behaviour of wholesalers, during periods of normal national supplies, still appears to be minimal. In these efforts, the main plank should be enlargement of fertilizer distribution credit to dealers. But even this may not suffice at all locations. Thus, there may not be any alternative to the option of BADC carrying larger inventories at downstream levels. It must, however, be recognized that by itself, this strategy will not generate sustained acceleration in consumption trends. These efforts by BADC, therefore, must be coordinated with the efforts of the agricultural extension and credit systems to generate growth in fertilizer demand.

8. A scrutiny of the monthly data on opening stocks, supplies, and sales for the seven-year period from 1977/78 to 1983/84 reveals that at the national level these time-series exhibit hardly any association (Figures 9 to 14). Thus it can neither be concluded that changes in aggregate demand were driving the changes in aggregate supplies nor the changes in aggregate supplies were driving the changes in aggregate sales. The data also show that the ratios of total monthly availability (i.e., monthly opening stocks and monthly supplies) to monthly sales were generally quite high (Table 12). If, despite these high ratios, problems of timely availability of fertilizers to farmers in particular localities

Figure 9. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Urea in Bangladesh from July 1977 to June 1983

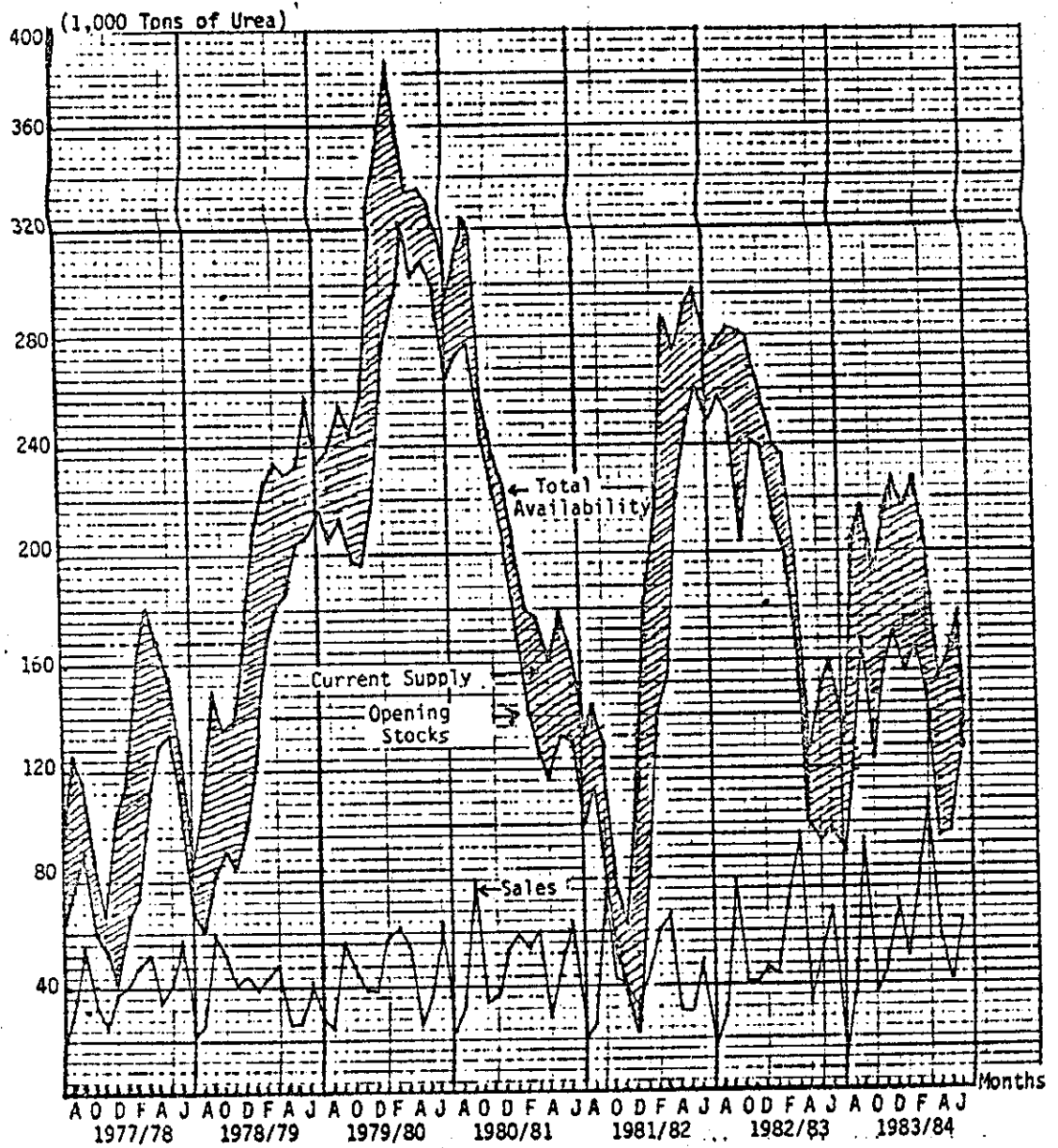




Figure 10. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Triple Superphosphate (TSP) in Bangladesh from July 1977 to June 1983

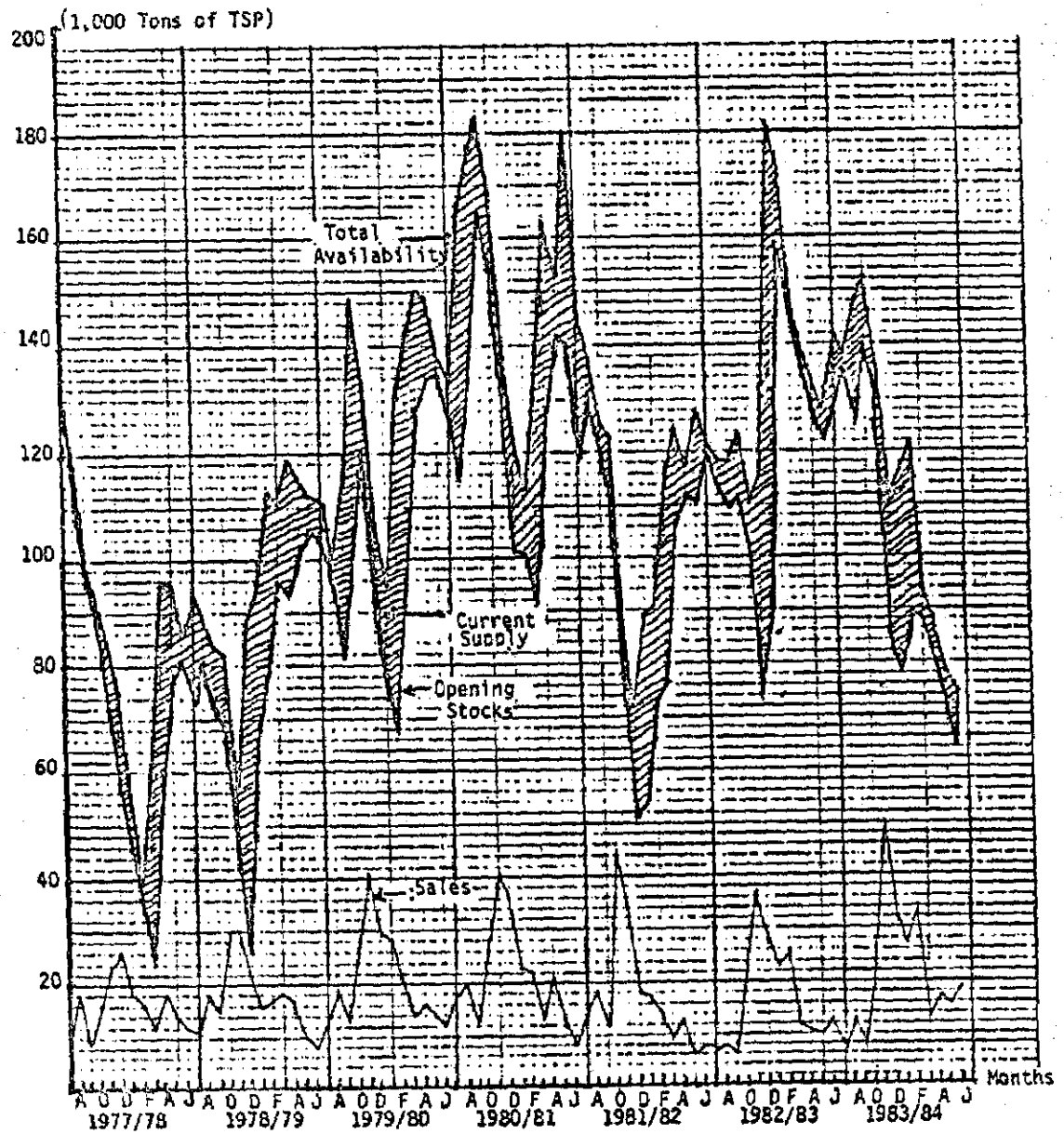
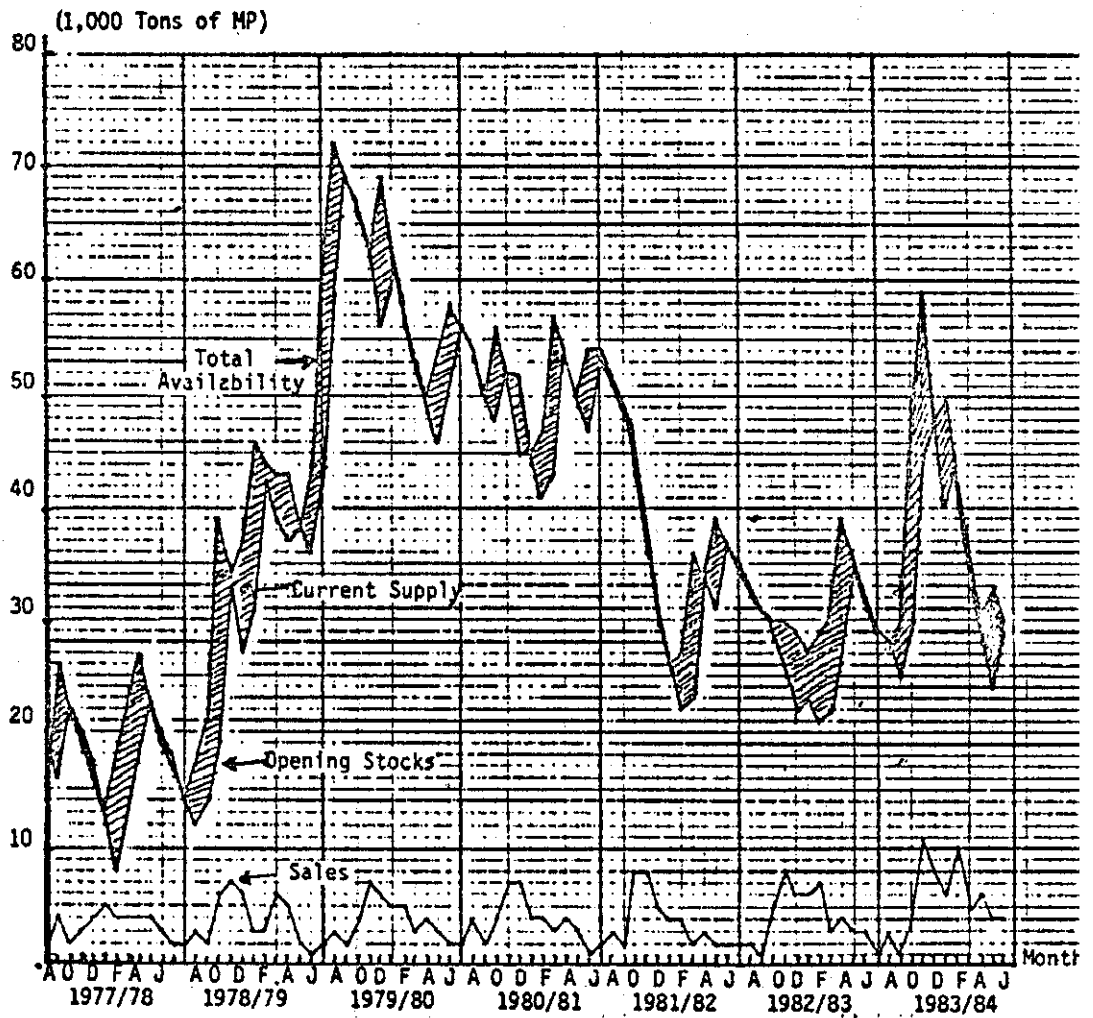
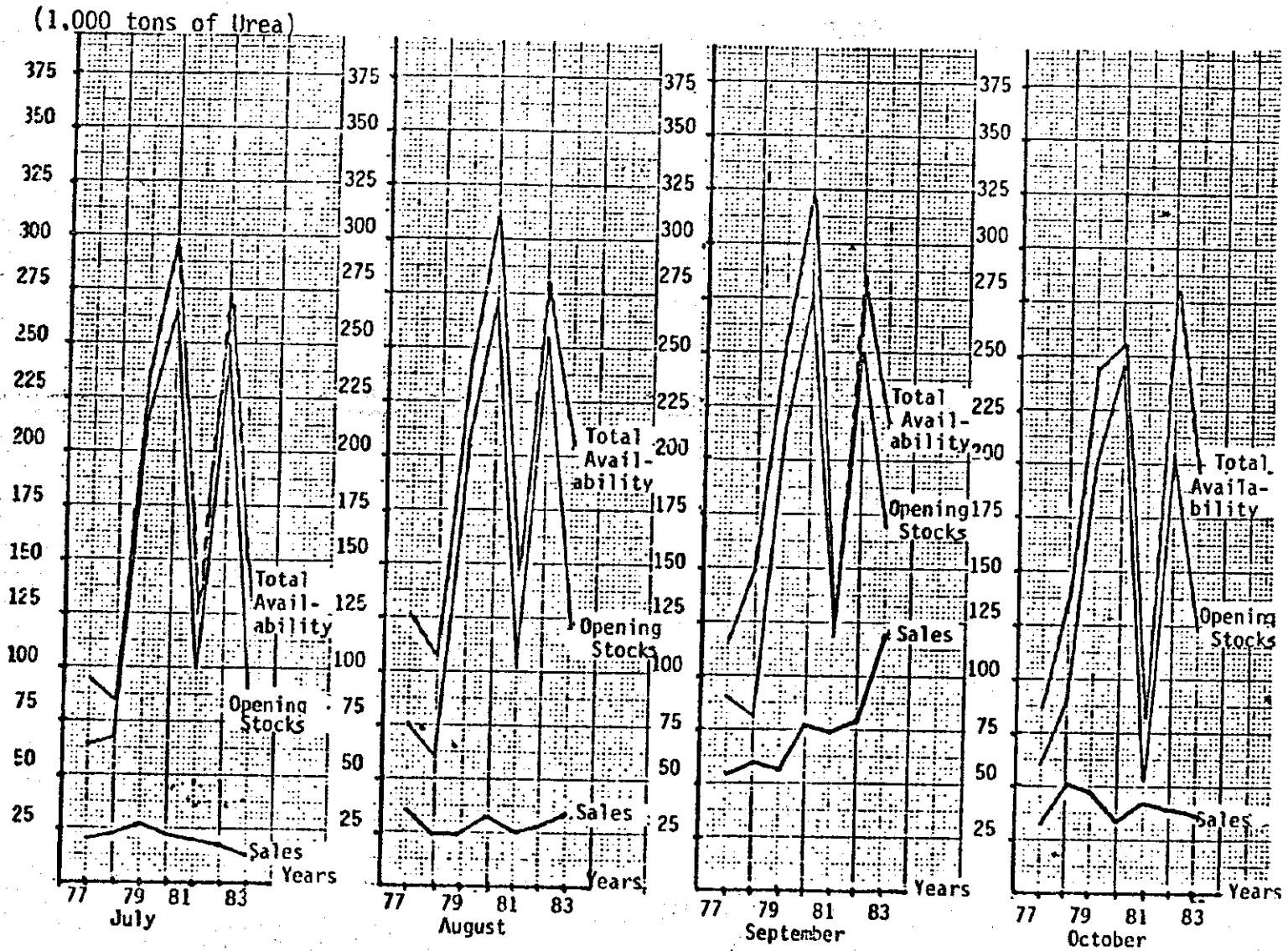


Figure 11. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Muriate of Potash (MP) in Bangladesh from July 1977 to June 1983



n Bangladesh,



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks.

Figure 12. Continued

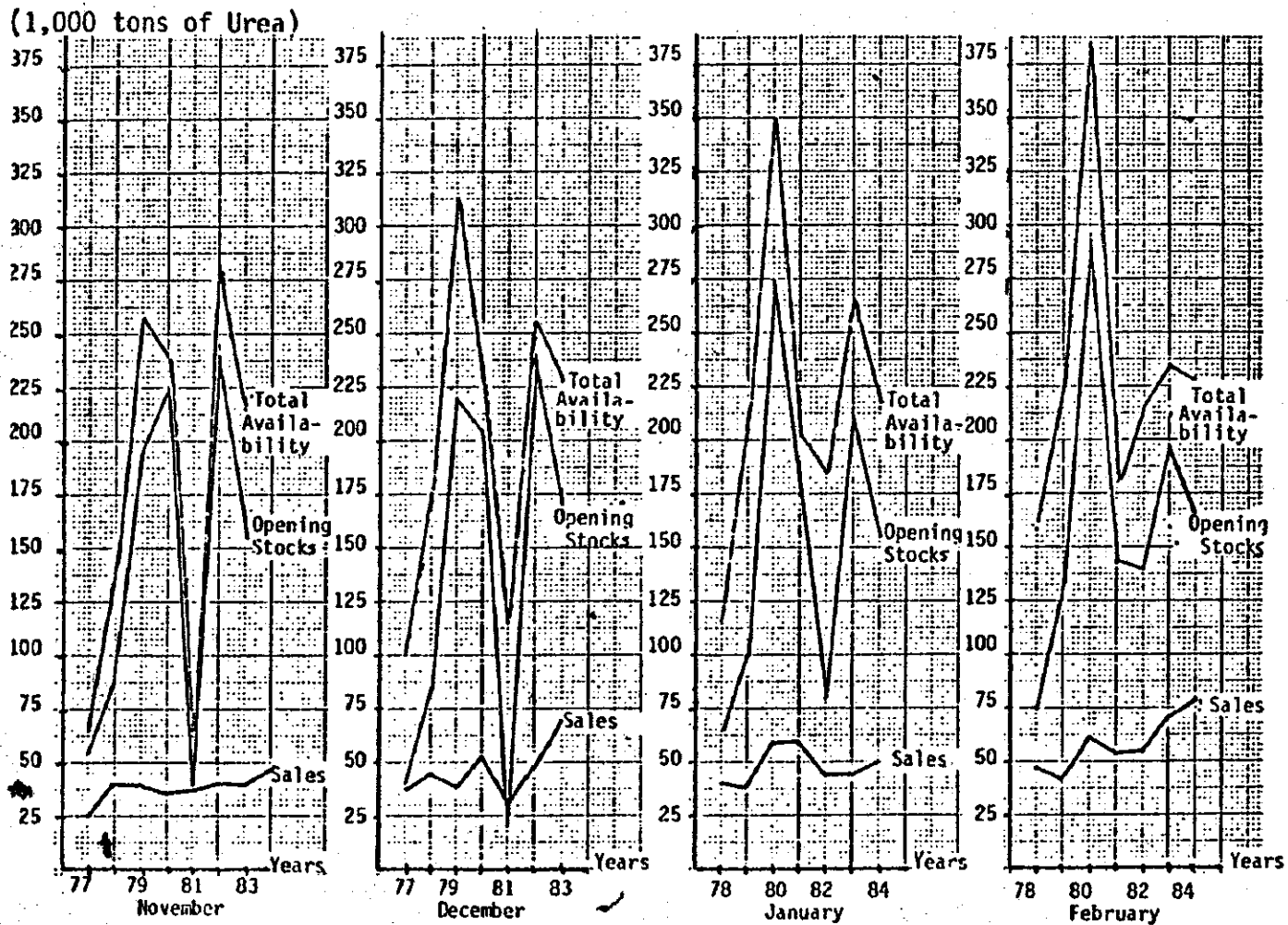


Figure 12. Continue

(1,000 tons of Urea)

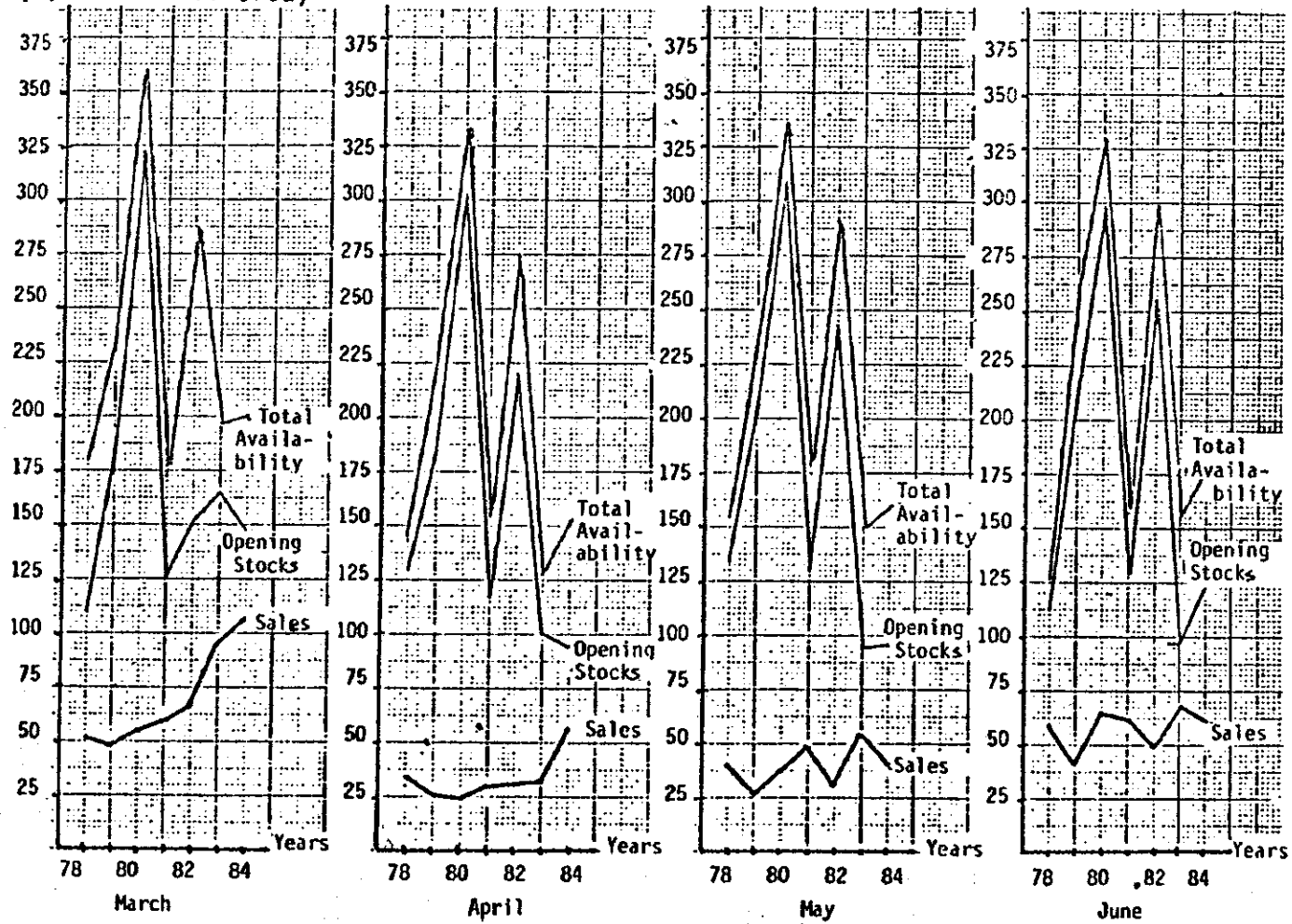
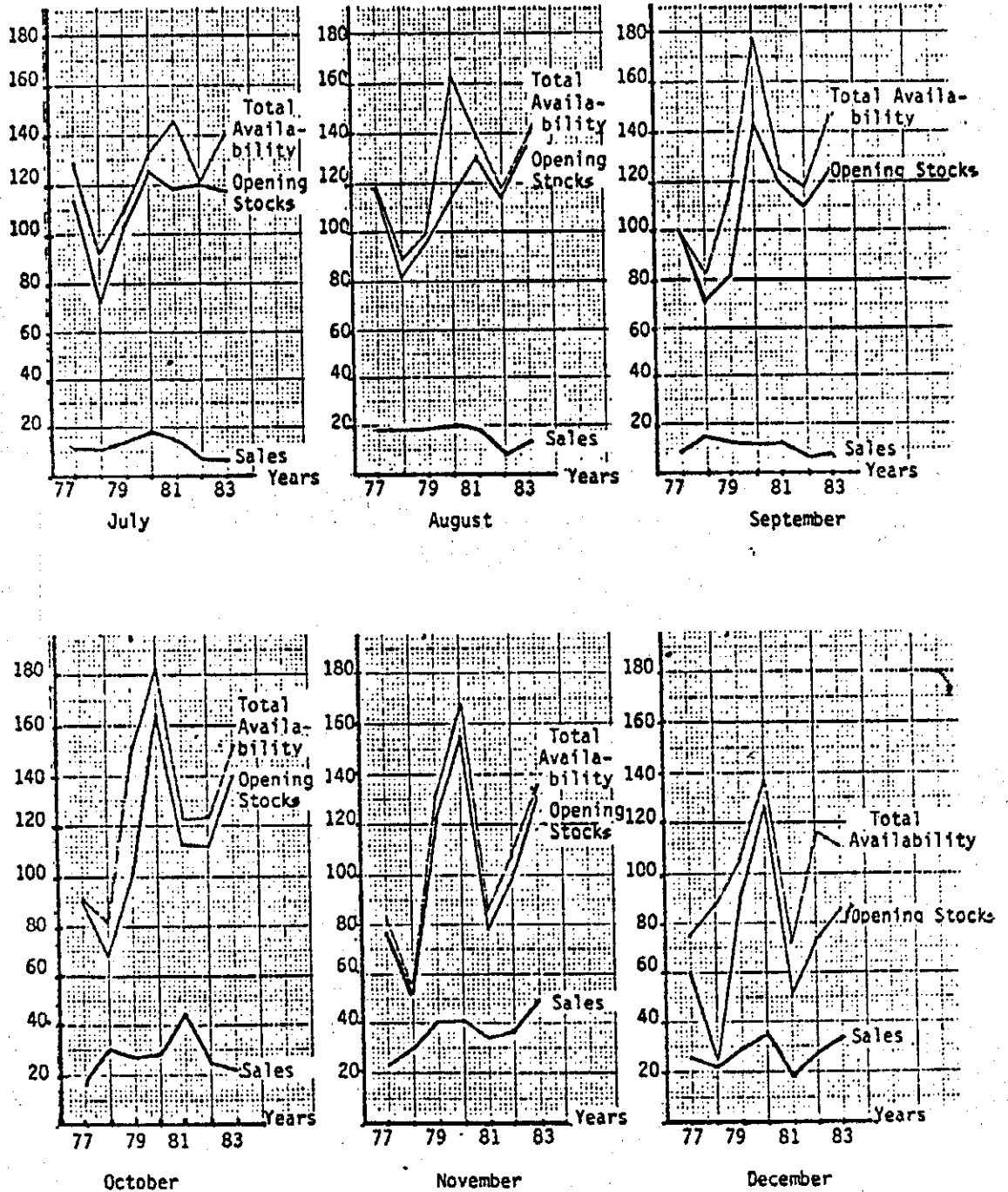


Figure 13. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Triple Superphosphate (TSP) in Bangladesh, 1977 to 1984

(1,000 tons of TSP)



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks.

Figure 13. Continued

(1,000 tons of TSP)

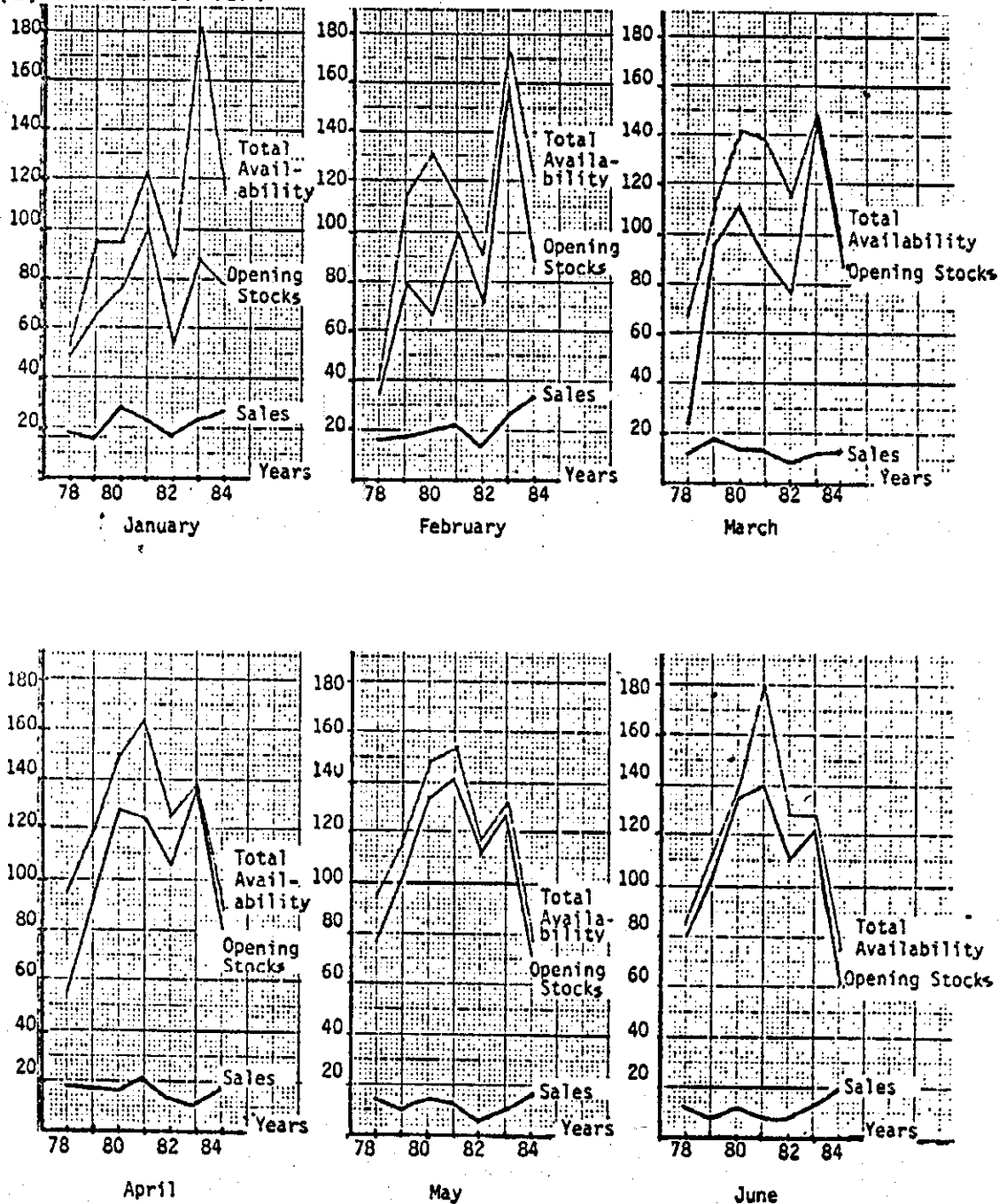
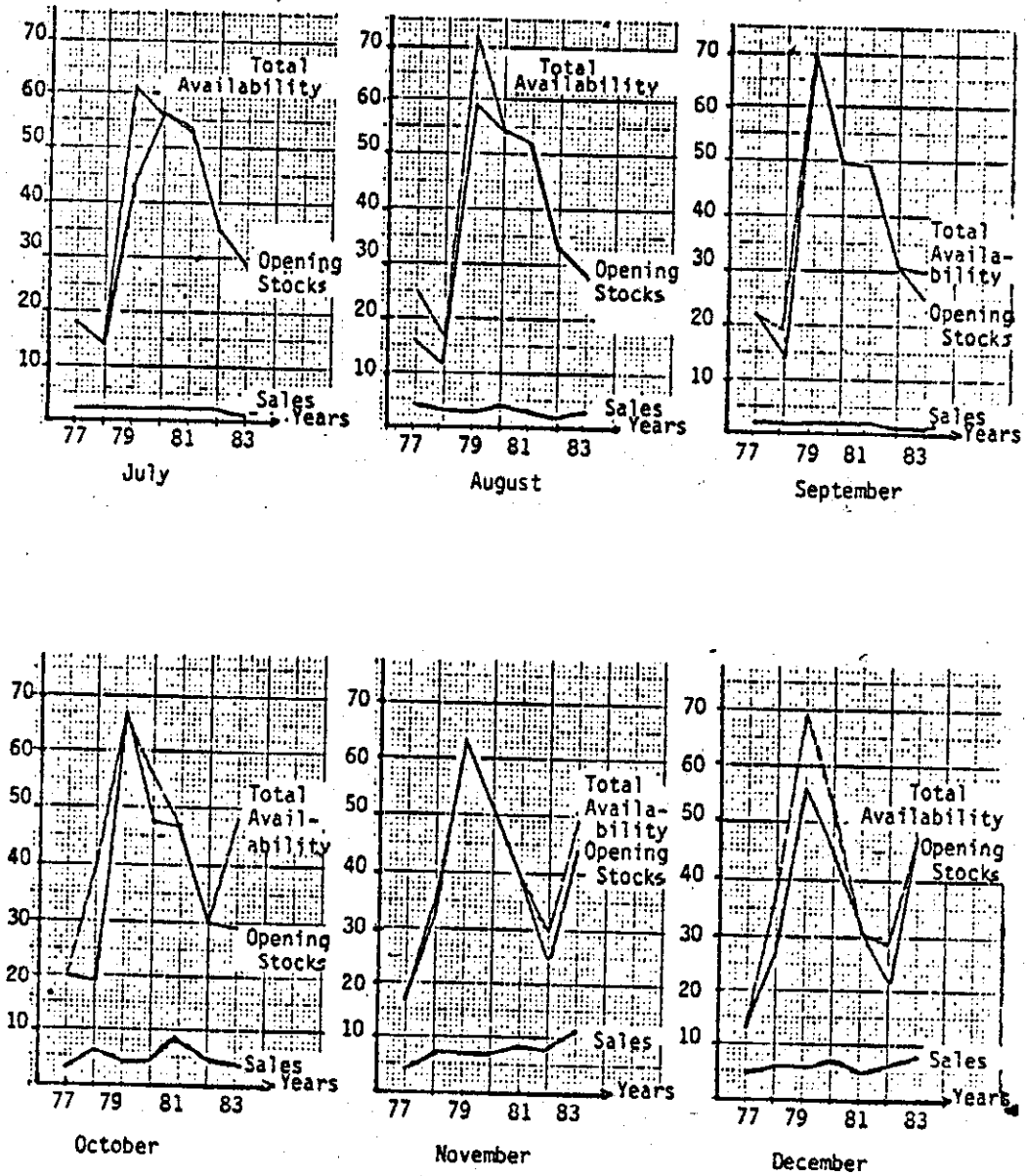


Figure 14. Monthly Opening Stocks, Current Supply, Total Availability and Sales of Muriate of Potash (MP) in Bangladesh, 1977 to 1984

(1,000 tons of MP)



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks.



Figure 14. Continued

(1,000 tons of MP)

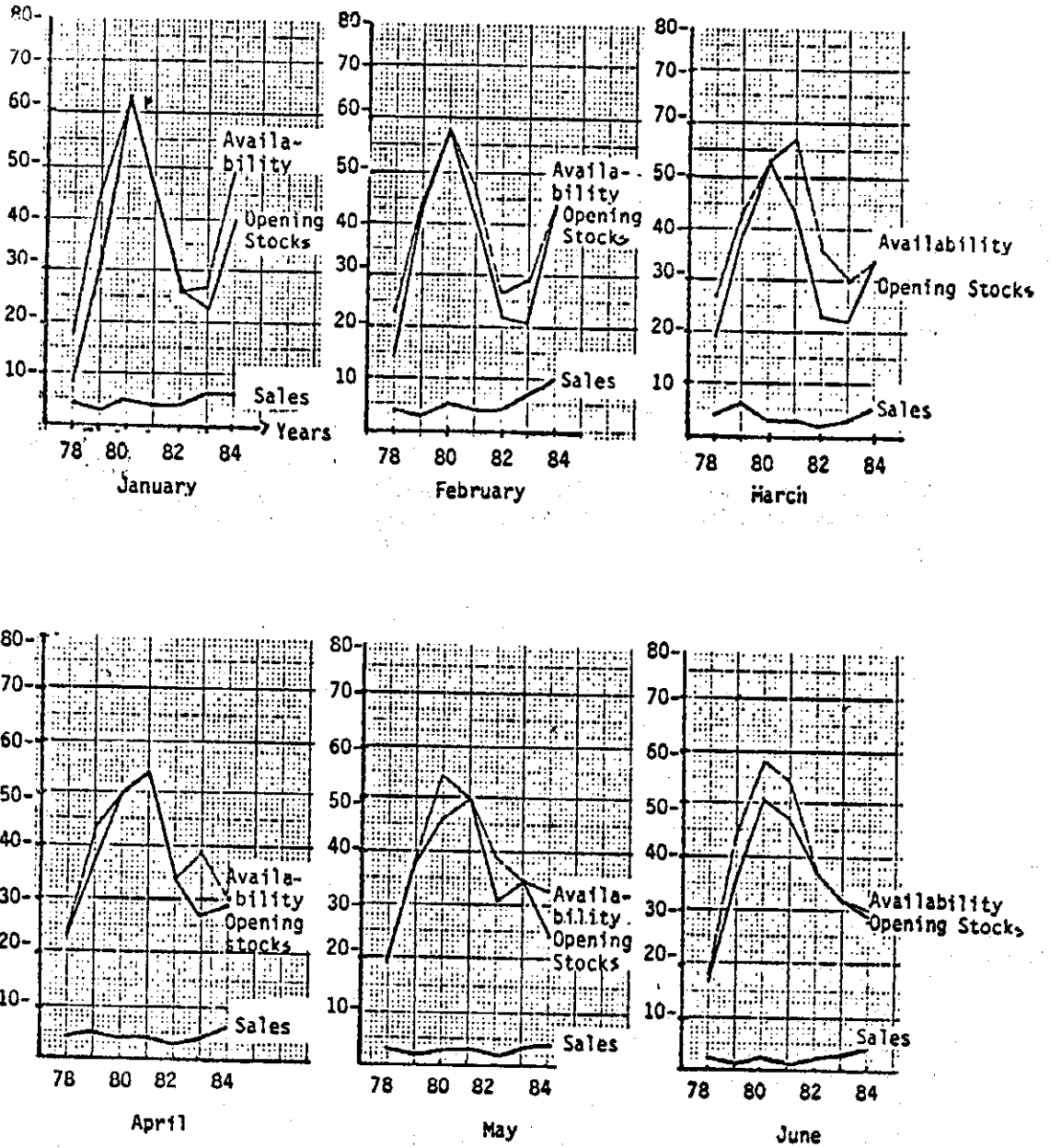


Table 12. Monthly sales, ratios of monthly opening stocks to monthly sales, and of monthly availability to monthly sales of urea, TSP, and MP in Bangladesh, 1977/78 to 1983/84

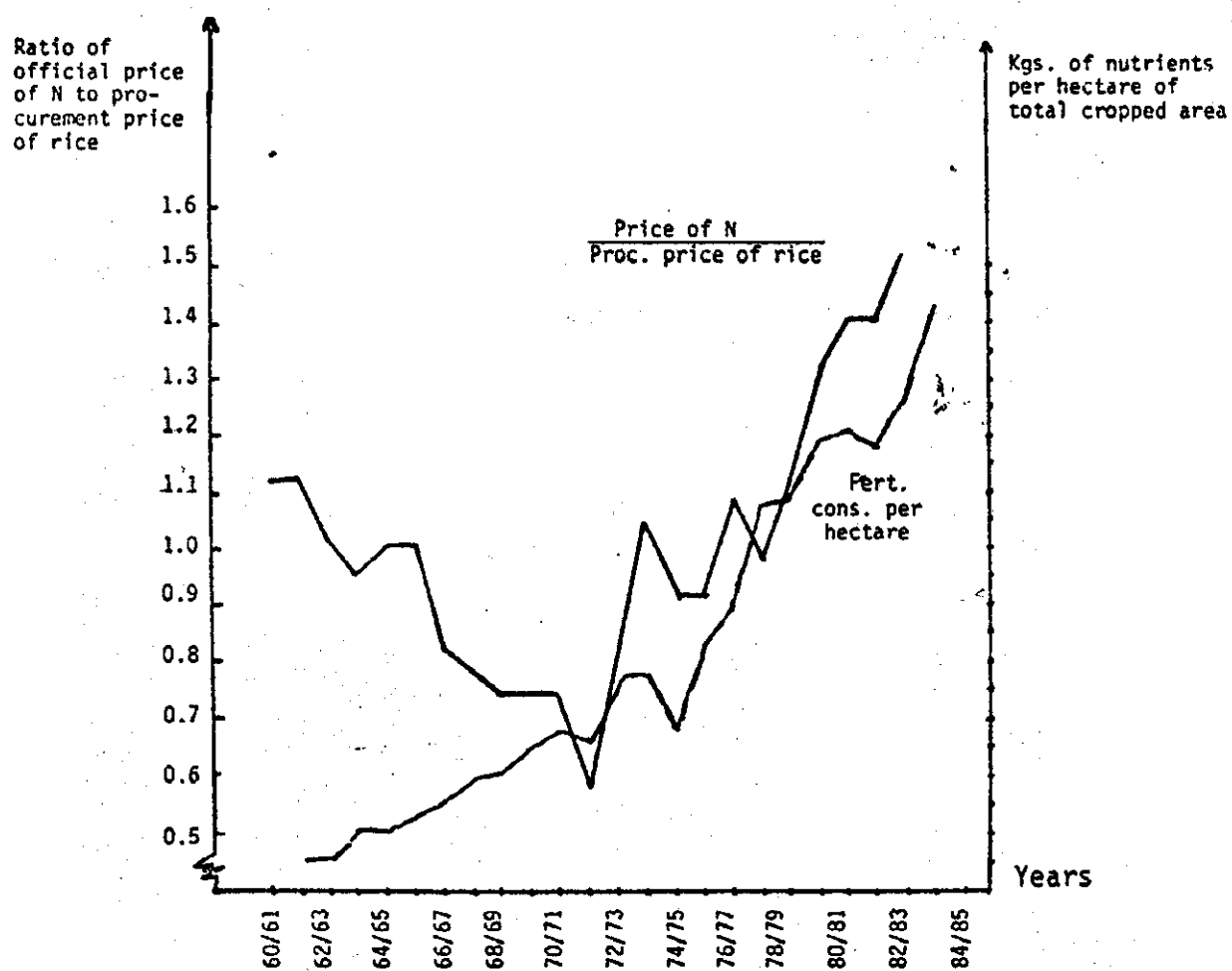
Year	Product	Sales				Monthly Opening Stock/ Monthly Sales				Monthly Availability/ Monthly Sales			
		Ave.	Min.	Max.	C.V.	Ave.	Min.	Max.	C.V.	Ave.	Min.	Max.	C.V.
(1,000 metric tons)													
1977/78	Urea	40	20	58	28	2.1	1.1	3.8	35.9	3.3	2.1	5.0	27.5
	TSP	16	9	26	30	5.1	2.0	11.1	58.5	6.0	2.5	11.8	48.1
	MP	4	2	5	25	5.7	2.0	11.0	45.8	6.5	2.6	11.0	32.9
1978/79	Urea	39	23	60	29	3.7	1.4	7.8	54.2	5.0	2.5	8.9	40.7
	TSP	18	8	30	38	5.3	1.2	13.1	61.4	6.6	4.0	14.1	50.4
	MP	4	1	7	51	10.3	3.2	36.0	86.3	12.4	5.7	43.5	83.2
1979/80	Urea	45	25	64	31	6.2	3.7	12.1	37.2	7.4	4.5	13.3	32.0
	TSP	21	12	41	41	6.0	2.8	11.3	46.1	7.1	3.2	11.5	39.7
	MP	4	2	7	41	17.2	9.0	34.5	41.2	19.0	9.0	34.5	43.1
1980/81	Urea	48	23	78	34	4.8	2.1	11.5	59.0	5.5	2.6	12.8	53.7
	TSP	21	8	41	44	7.4	3.5	17.5	53.7	8.9	3.1	22.7	59.1
	MP	4	1	7	46	17.1	6.4	47.0	63.6	18.3	7.4	52.6	65.1
1981/82	Urea	41	20	74	48	3.4	0.7	7.8	69.7	4.8	1.6	19.4	52.5
	TSP	17	6	45	62	7.5	2.3	18.7	63.2	8.9	2.5	19.6	56.9
	MP	4	2	8	51	10.1	3.0	31.0	78.4	10.9	3.8	31.0	69.3
1982/83	Urea	52	17	96	43	4.9	1.4	14.6	74.1	5.7	2.1	16.1	66.7
	TSP	17	7	50	56	6.8	2.6	17.9	76.9	7.8	2.7	20.8	77.4
	MP	4	1	8	51	10.1	3.0	31.0	78.4	10.9	3.8	31.0	69.3
1983/84	Urea	58	13	107	44	2.8	1.4	6.8	49.8	4.1	1.9	10.2	51.9
	TSP	22	7	50	56	6.8	2.6	17.9	76.9	7.8	2.7	20.8	77.4
	MP	5	1	11	58	9.8	4.0	29.0	80.5	11.1	4.4	30.3	78.1

Sources: Developed from data available in Bangladesh Ministry of Agriculture, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project, (Dhaka, Bangladesh Ministry of Agriculture and U.S. Agency for International Development, November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984.

occurred, then it is clear that there was considerable scope to improve the workings of the distribution system. Efforts in this direction are required not only to make adequate fertilizers available to farmers at the right time and place, but also to lower fertilizer distribution costs, and thus lower farmers' fertilizer prices.

9. Figures 9 to 14, as well as Table 12, also show that there was comfortable aggregate availability of fertilizer in most of the years between 1977/78 and 1983/84. Aggregate growth in fertilizer sales during the period (based on 1977/78) averaged 7.8 percent per annum, a respectable rate, but hardly one that can be considered rapid or adequate to Bangladesh's requirements. It is therefore pertinent to ask why was sales growth not more rapid, since it was constrained neither by (in general) aggregate supplies, nor by the agronomic potential for fertilizer use. The answer to this question cannot lie with the price environment or changes in that environment, for two reasons. First, the environment was still quite favourable. As shown in Table 4, the cost of a kilogram of nitrogen was still less than 1.5 kilograms of rice (or, that of a kilogram of urea was less than 1.1 kilograms of paddy). Second, and more importantly, there was substantial growth in fertilizer use between 1977/78 and 1983/84 despite, on balance, adverse changes in the price environment (Figure 15). Thus, the explanation behind slower growth in actual fertilizer consumption, despite comfortable aggregate fertilizer availability and sizeable untapped potential seems to lie in lack of well-coordinated efforts by agricultural research, extension, and credit systems to convert the potential into farmers' demand, and by the fertilizer distribution system to meet this demand at geographically dispersed locations. It is important to be aware of these areas of implied deficiency when formulating future policies. The enlargement of aggregate

Figure 15. Growth of Fertilizer Consumption and Changes in Ratio of Official Price of Nitrogen to Procurement Price of Rice, Bangladesh, 1960/61 to 1983/84



Note: Price data not available for 1983/84.

fertilizer supply is a necessary, but not a sufficient condition to generate sustainable rapid growth in fertilizer consumption. It has to be supplemented in a well-coordinated manner by demand-creation activities of the nature described above, and continuous improvements in the operations of the fertilizers distribution system at all levels.

3.12 Consistent with the above discussion, it is clear that at the present stage a new orientation is required in the thinking behind policies for sustained rapid growth in Bangladesh's fertilizer consumption. The current emphasis on prices needs to be replaced by concentration on productivity and efficiency of fertilizer use as key target variables in policies aimed at raising farmers' returns to fertilizer use, and supplemented by adequate flows of institutional credit to enable them to buy fertilizers. Different factors affecting growth in actual fertilizer use need to be viewed, not in isolation from each other, but as a set of interacting variables which can be manipulated through appropriate policy interventions. The dominant aim of these interventions should be faster development and well-coordinated, as well as efficient operation of systems of agricultural research, extension, and credit, and of fertilizer production, import, procurement, stock management, and distribution.

## Appendix A

Table A1. Monthly opening stocks, current supply, availability, sales and closing stocks of urea in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Avail- ability (1)+(2)	Sales	Closing		(4): (3)	(4): (1)	
					Stocks (3)	(4) as % of (3)			
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of ferti. materials)				(percent)				
<u>1977/78</u>									
July	65	31	96	20	76	20.8	67.7	1:4.8	1:3.3
August	76	50	126	35	91	27.8	60.3	1:3.6	1:2.2
September	91	25	116	55	61	47.4	78.4	1:2.1	1:1.7
October	61	26	87	33	54	37.9	70.1	1:2.6	1:1.8
November	54	12	66	25	41	37.9	81.0	1:2.6	1:2.2
December	41	62	103	37	66	35.9	39.8	1:2.8	1:1.1
January	66	49	115	41	74	35.7	57.4	1:2.8	1:1.6
February	74	84	158	48	110	30.4	46.8	1:3.3	1:1.5
March	110	71	181	52	129	28.7	61.1	1:3.5	1:2.1
April	129	39	168	34	134	20.2	76.8	1:5.0	1:3.8
May	134	20	154	41	113	26.6	87.0	1:3.8	1:3.3
June	113	13	126	50	68	46.0	89.7	1:2.2	1:1.9
<u>1978/79</u>									
July	68	16	84	23	61	27.4	81.0	1:3.6	1:3.0
August	61	46	107	25	82	23.4	57.0	1:4.3	1:2.4
September	82	68	150	60	90	40.0	54.7	1:2.5	1:1.4
October	90	46	136	52	84	38.2	66.2	1:2.6	1:1.7
November	84	56	140	41	99	29.3	60.0	1:3.4	1:2.0
December	99	77	176	44	132	25.0	56.3	1:4.0	1:2.3
January	132	74	206	39	167	18.9	63.2	1:5.3	1:3.4
February	167	57	224	43	181	19.2	74.6	1:5.2	1:3.9
March	181	53	234	48	186	20.5	77.4	1:4.9	1:3.8
April	186	44	230	26	204	11.3	80.9	1:8.8	1:7.2
May	204	29	233	26	207	11.2	87.6	1:8.9	1:7.8
June	207	51	258	42	216	16.3	80.2	1:6.1	1:4.9
<u>1979/80</u>									
July	216	17	233	28	205	12.0	92.7	1:8.3	1:7.7
August	205	33	238	25	213	10.5	86.1	1:9.4	1:8.2
September	213	42	255	57	190	22.4	83.5	1:4.5	1:3.7
October	198	46	244	48	196	19.7	81.1	1:5.1	1:4.1
November	196	62	258	39	219	15.1	76.0	1:6.6	1:5.0
December	219	94	313	38	275	12.1	70.0	1:8.3	1:5.8
January	275	76	351	50	293	16.5	73.3	1:6.1	1:4.7
February	293	92	385	62	323	16.1	76.1	1:6.2	1:4.7
March	323	35	358	55	303	15.3	80.2	1:6.5	1:5.9
April	303	30	333	25	308	7.5	91.0	1:13.3	1:12.1
May	308	27	335	37	298	11.0	91.9	1:9.1	1:8.3
June	298	31	329	64	265	19.5	90.6	1:5.1	1:4.7

## Appendix A

Table A1. (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail- ability (1)+(2)	Sales Spills	Closing Stocks (3)-(4)	(4) as % of (3)	(1) as % of (3)	(4):(3)	(4):(1)
(1,000 long tons of ferti. materials)						(percent)			
<u>1980/81</u>									
July	265	31	296	23	273	7.8	89.5	1:12.8	1:11.5
August	273	37	310	33	277	10.6	88.1	1:9.4	1:8.3
September	277	47	324	78	246	24.1	85.5	1:4.1	1:3.6
October	246	14	260	34	226	13.1	94.6	1:7.6	1:7.2
November	226	14	240	36	204	15.0	94.2	1:6.7	1:6.3
December	204	23	227	53	174	23.3	89.9	1:4.3	1:3.8
January	174	28	202	59	143	29.2	86.1	1:3.4	1:2.9
February	143	37	180	54	126	30.0	79.4	1:3.3	1:2.6
March	126	51	177	60	117	33.9	71.2	1:2.9	1:2.1
April	117	43	160	28	132	17.5	73.1	1:5.7	1:4.2
May	132	47	179	49	130	27.4	73.7	1:3.6	1:2.7
June	130	33	163	63	100	38.7	79.8	1:2.6	1:2.1
<u>1981/82</u>									
July	100	32	132	20	112	15.2	75.8	1:6.6	1:5.0
August	112	32	144	26	118	18.1	77.8	1:5.5	1:4.3
September	118	9	127	74	53	50.3	92.9	1:1.7	1:1.6
October	53	28	81	43	38	53.1	65.4	1:1.9	1:1.2
November	30	24	62	40	22	64.5	61.3	1:1.6	1:1.0
December	22	92	114	33	81	28.9	19.3	1:3.5	1:0.7
January	81	103	184	44	140	23.9	44.0	1:4.2	1:1.8
February	140	74	214	61	153	28.5	65.4	1:3.5	1:2.3
March	153	134	287	67	220	23.3	53.3	1:4.3	1:2.3
April	220	54	274	31	243	11.3	80.3	1:8.8	1:7.1
May	243	49	292	31	261	10.6	83.2	1:9.4	1:7.8
June	261	37	298	49	249	16.4	87.6	1:6.1	1:5.3
<u>1982/83</u>									
July	249	24	273	17	256	6.2	91.2	1:16.1	1:14.6
August	256	23	279	28	251	10.0	91.8	1:10.0	1:9.1
September	251	32	283	79	204	27.9	88.7	1:3.6	1:3.2
October	204	78	282	41	241	14.5	72.3	1:6.9	1:5.0
November	241	39	280	41	239	14.6	86.1	1:6.8	1:5.9
December	239	20	259	47	212	18.1	92.3	1:5.5	1:5.1
January	212	29	241	44	197	18.3	88.0	1:5.5	1:4.8
February	197	39	236	71	165	30.1	83.5	1:3.3	1:2.8
March	165	32	197	96	101	48.7	83.8	1:2.1	1:1.7
April	101	26	127	33	94	26.0	79.5	1:3.8	1:3.1
May	94	57	151	54	97	35.8	62.3	1:2.8	1:1.7
June	97	63	160	67	93	41.9	60.6	1:2.4	1:1.4

## Appendix A

Table A1. (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail-	Sales	Closing	(4) as (3) % of (3)	(1) as (3) % of (3)	(4):(3)	(4):(1)
			ability (1)+(2)		Stocks (3)-(4)				
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of ferti. materials)					(percent)			
<u>1983/84</u>									
July	89	43	132	13	119	9.8	67.4	1:10.2	1:6.8
August	119	85	204	36	160	17.6	58.3	1:5.7	1:3.3
September	168	49	217	94	123	43.3	77.4	1:2.3	1:1.0
October	123	69	192	37	155	19.3	64.1	1:5.2	1:3.3
November	155	61	216	47	169	21.8	71.8	1:4.6	1:3.3
December	169	58	227	71	156	31.3	74.4	1:3.2	1:2.4
January	156	60	216	50	166	23.1	72.2	1:4.3	1:3.1
February	166	62	228	81	147	35.5	72.8	1:2.8	1:2.0
March	147	54	201	107	94	53.2	73.1	1:1.9	1:1.4
April	94	59	153	57	96	37.3	61.4	1:2.7	1:1.6
May	96	69	165	41	124	24.8	58.2	1:4.0	1:2.3
June	124	54	178	63	115	35.4	69.7	1:2.8	1:2.0

Sources: Data developed from Bangladesh Ministry of Agriculture, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project (Dhaka, November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued 7 August 1983 and 8 August 1984, respectively.



Table A2. Monthly opening stocks, current supply, availability, sales and closing stocks of triple superphosphate (TSP) in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Avail- ability (1)+(2)	Sales	Closing Stocks		(4):(3)	(4):(1)	
					(3)-(4)	(1) as % of (3)			
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of fertilizer materials)				(percent)				
<u>1977/78</u>									
July	114	15	129	11	118	8.5	98.4	1:11.8	1:10.4
August	118	0	118	18	100	15.3	100.0	1:6.5	1:6.6
September	100	0	100	9	91	9.0	100.0	1:11.1	1:11.1
October	91	0	93	16	77	17.2	100.0	1:5.8	1:5.7
November	77	7	84	23	61	27.4	91.7	1:3.6	1:3.3
December	61	14	75	26	49	34.7	81.3	1:2.9	1:2.3
January	49	4	53	18	35	34.0	92.5	1:2.9	1:2.7
February	35	5	40	16	24	40.0	87.5	1:2.5	1:2.2
March	24	43	67	12	55	17.9	35.8	1:5.6	1:2.0
April	55	40	95	18	77	18.9	57.9	1:5.3	1:3.1
May	77	18	95	14	81	14.7	81.1	1:6.8	1:5.5
June	81	4	85	12	73	14.1	95.3	1:7.1	1:6.8
<u>1978/79</u>									
July	73	20	93	11	82	11.8	78.5	1:8.5	1:6.6
August	82	7	89	18	71	20.2	92.5	1:5.0	1:4.6
September	71	12	83	15	68	18.1	85.5	1:5.5	1:4.7
October	68	14	82	30	52	36.6	82.9	1:2.7	1:2.3
November	52	4	56	30	26	53.6	92.9	1:1.9	1:1.7
December	26	62	88	22	66	25.0	29.5	1:4.0	1:1.2
January	66	29	95	16	79	16.8	69.5	1:6.0	1:4.1
February	79	34	113	17	96	15.0	69.9	1:6.7	1:4.6
March	96	15	111	18	93	16.2	86.5	1:6.2	1:5.3
April	93	26	119	17	102	14.3	78.2	1:7.0	1:5.5
May	102	13	115	10	105	8.7	88.7	1:11.5	1:10.2
June	105	7	112	8	104	7.1	93.8	1:14.1	1:13.1
<u>1979/80</u>									
July	104	7	111	14	97	12.6	93.7	1:7.9	1:7.4
August	97	3	100	19	81	19.0	97.0	1:5.3	1:5.1
September	81	34	115	13	102	11.3	70.4	1:8.8	1:6.2
October	102	47	149	27	122	18.1	68.5	1:5.5	1:3.8
November	122	9	131	41	90	31.3	93.1	1:3.2	1:3.0
December	90	16	106	29	77	27.4	84.9	1:3.6	1:3.1
January	77	18	95	28	67	29.5	81.1	1:3.4	1:2.8
February	67	64	131	20	111	15.3	51.1	1:6.5	1:3.4
March	111	31	142	14	128	9.9	78.2	1:10.1	1:7.9
April	128	22	150	16	134	10.7	85.3	1:9.3	1:8.0
May	134	15	149	14	135	9.4	89.9	1:10.6	1:9.6
June	135	3	138	12	126	8.7	97.8	1:11.5	1:11.3

Table A2. (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail.	Sales	Closing	(4) as % of (3)	(1) as % of (3)	(4):(3)	(4):(1)
			(1)+(2)		Stocks (3)-(4)				
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of fert. materials)				(percent)				
<u>1980/81</u>									
July	126	7	133	18	115	13.5	94.7	1:7.4	1:7.0
August	115	48	163	20	143	12.3	70.6	1:8.1	1:5.8
September	143	34	177	12	165	6.8	80.8	1:14.7	1:11.9
October	165	18	183	28	155	15.3	90.2	1:6.5	1:5.9
November	155	13	168	41	127	32.3	92.3	1:3.1	1:3.8
December	127	10	137	36	101	26.3	92.7	1:3.8	1:3.5
January	101	22	123	23	100	18.7	82.1	1:5.3	1:4.4
February	100	13	113	22	91	19.5	80.5	1:5.1	1:4.5
March	91	47	138	13	125	9.4	65.9	1:10.6	1:7.0
April	125	38	163	21	142	12.9	76.7	1:7.8	1:6.0
May	142	11	153	13	140	8.5	92.8	1:11.8	1:10.9
June	140	40	180	8	172	4.4	77.8	1:22.7	1:17.5
<u>1981/82</u>									
July	172	27	146	15	131	10.3	81.5	1:9.7	1:7.9
August	131	7	138	18	120	13.0	94.9	1:7.7	1:7.3
September	120	5	125	12	113	9.6	96.0	1:10.4	1:10.0
October	113	10	123	45	78	36.6	91.9	1:2.7	1:2.5
November	78	7	85	34	51	40.0	91.8	1:2.5	1:2.3
December	51	21	72	18	54	25.0	70.8	1:4.0	1:2.8
January	54	35	89	17	72	19.1	60.7	1:5.2	1:3.2
February	72	19	91	14	77	15.4	79.1	1:6.5	1:5.8
March	77	38	115	9	106	7.0	67.0	1:12.8	1:8.6
April	106	19	125	13	112	10.4	84.8	1:9.6	1:8.2
May	112	5	117	6	111	5.1	95.7	1:19.6	1:18.7
June	111	17	128	8	120	6.3	86.7	1:15.9	1:13.9
<u>1982/83</u>									
July	120	1	121	7	114	5.8	99.2	1:17.2	1:17.1
August	114	4	118	8	110	6.8	96.6	1:14.7	1:14.3
September	110	8	118	6	112	5.1	93.2	1:19.6	1:18.3
October	112	12	124	24	100	19.4	90.3	1:5.2	1:4.7
November	100	10	110	37	73	33.6	90.9	1:3.0	1:2.7
December	73	44	117	28	89	23.9	62.4	1:4.3	1:2.6
January	89	93	182	23	159	12.6	48.9	1:7.9	1:3.9
February	159	14	173	26	147	15.0	91.9	1:6.7	1:6.1
March	147	2	149	12	137	8.1	98.7	1:12.3	1:12.3
April	137	1	138	11	127	8.0	99.3	1:12.5	1:12.5
May	127	5	132	10	122	7.6	96.2	1:13.2	1:12.7
June	122	6	128	13	115	10.2	95.3	1:9.8	1:9.4

## Appendix A

Table A2 (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail-	Sales	Closing		(4) as % of (3)	(1) as % of (3)	(4):(3)	(4):(1)
			(1)+(2)		Stocks (3)-(4)	(4)				
	1	2	3	4	5	6	7	8	9	
	(1,000 long tons of fertilizer materials) (percent)									
<u>1983/84</u>										
July	118	24	142	7	135	4.9	83.1	1:20.4	1:16.9	
August	135	3	138	13	125	9.4	97.8	1:10.6	1:10.4	
September	125	22	147	7	140	4.8	85.0	1:20.8	1:17.9	
October	140	13	153	22	131	14.4	91.5	1:6.9	1:6.4	
November	131	5	136	50	86	36.8	96.3	1:2.7	1:2.6	
December	86	25	111	33	78	29.7	77.5	1:3.4	1:2.6	
January	70	38	116	27	89	23.3	67.2	1:4.3	1:2.9	
February	89	33	122	34	88	27.9	73.0	1:3.6	1:2.6	
March	88	6	94	13	81	13.8	93.6	1:7.2	1:6.8	
April	81	7	88	17	71	19.3	92.0	1:5.2	1:4.8	
May	71	7	78	16	62	20.5	91.0	1:4.9	1:4.4	
June	62	13	75	19	56	25.3	82.7	1:4.0	1:3.3	

Source: Data developed from Bangladesh Ministry of Agriculture, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project (Dhaka, November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued 7 August 1983 and 8 August 1984, respectively.

Appendix A

Table A3. Monthly opening stocks, current supply, availability, sales and closing stocks of muriate of potash (MP) in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Availa- bility (1)+(2)	Sales	Closing Stocks		(4):(3)	(4):(1)	
					(3)-(4)	(1) as % of (3)			
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of ferti. materials)				(percent)				
<u>1977/78</u>									
July	18	0	18	2	16	11.1	100.0	1:9.0	1:9.0
August	16	10	26	4	22	15.4	61.5	1:6.5	1:4.0
September	22	0	22	2	20	9.1	100.0	1:11.0	1:11.0
October	17	0	17	4	13	23.5	100.0	1:4.3	1:4.3
December	13	0	13	5	8	38.5	100.0	1:2.6	1:2.6
January	8	10	18	4	14	22.2	80.0	1:4.5	1:2.0
February	14	9	23	4	19	17.4	60.9	1:5.7	1:3.5
March	19	8	27	4	23	14.8	70.4	1:6.8	1:4.8
April	23	0	23	4	19	17.4	100.0	1:5.7	1:5.8
May	19	1	20	3	17	15.0	95.0	1:6.7	1:6.3
June	17	1	16	2	14	12.5	94.4	1:8.0	1:8.5
<u>1978/79</u>									
July	14	0	14	2	12	14.3	100.0	1:7.0	1:7.0
August	12	5	17	3	14	17.6	70.6	1:5.7	1:4.0
September	14	7	21	2	19	9.5	66.6	1:10.5	1:7.0
October	19	20	39	6	33	15.4	48.7	1:6.5	1:3.2
November	33	1	34	7	27	20.6	97.1	1:4.9	1:4.7
December	27	10	37	6	31	16.2	73.0	1:6.2	1:4.5
January	31	15	46	3	43	6.5	67.4	1:15.4	1:10.3
February	43	1	42	3	39	7.1	97.7	1:14.1	1:14.3
March	39	6	43	6	37	14.0	90.7	1:7.1	1:6.5
April	37	6	43	5	38	11.6	86.0	1:8.6	1:7.4
May	38	0	38	2	36	5.3	100.0	1:18.9	1:19.0
June	36	6	44	1	43	2.3	81.8	1:43.5	1:36.0
<u>1979/80</u>									
July	43	18	61	2	59	3.3	70.5	1:30.3	1:21.5
August	59	13	72	3	69	4.2	81.9	1:23.8	1:19.7
September	69	0	69	2	67	2.9	100.0	1:34.5	1:34.5
October	67	0	67	4	63	6.0	100.0	1:16.7	1:16.8
November	63	0	63	7	56	11.1	100.0	1:9.0	1:9.0
December	56	56	13	6	63	8.7	81.2	1:11.5	1:9.13
January	63	0	63	5	58	7.9	100.0	1:12.7	1:12.6
February	58	0	58	5	53	8.6	100.0	1:11.6	1:11.6
March	53	0	53	3	50	5.7	100.0	1:17.5	1:17.7
April	50	0	50	4	46	8.0	100.0	1:12.5	1:12.5
May	46	8	54	3	51	5.6	85.2	1:17.9	1:15.3
June	51	7	58	2	56	3.4	87.9	1:25.4	1:25.5

## Appendix A

Table A3. (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail.	Sales	Closing	(4) as % of (3)	(1) as % of (3)	(4):(3)	(4):(1)
			(1)+(2)		Stocks (3)-(4)				
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of ferti. materials)				(percent)				
<u>1980/81</u>									
July	56	0	56	2	54	3.6	100.0	1:27.8	1:28.0
August	54	0	54	4	50	7.4	100.0	1:13.5	1:13.5
September	50	0	50	2	48	4.0	100.0	1:25.0	1:25.0
October	48	8	56	4	52	7.1	85.7	1:14.1	1:12.0
November	52	0	52	7	45	13.5	100.0	1:7.4	1:7.4
December	45	7	52	7	45	13.5	86.5	1:7.4	1:6.4
January	45	0	45	4	41	8.9	100.0	1:11.2	1:11.3
February	41	6	47	4	43	8.5	87.2	1:11.8	1:10.3
March	43	14	57	3	54	5.3	75.4	1:18.9	1:14.3
April	54	0	54	4	50	7.4	100.0	1:13.5	1:13.5
May	50	0	50	3	47	6.0	100.0	1:16.7	1:16.7
June	47	7	54	1	53	1.9	87.0	1:52.6	1:47.0
<u>1981/82</u>									
July	53	1	54	2	52	3.7	98.1	1:27.0	1:26.5
August	52	0	52	3	49	5.8	100.0	1:17.2	1:17.3
September	49	0	49	2	47	4.1	100.0	1:24.4	1:24.5
October	47	0	47	8	39	17.0	100.0	1:5.9	1:5.9
November	39	0	39	8	31	20.5	100.0	1:4.9	1:4.9
December	31	0	31	5	26	16.1	100.0	1:6.2	1:6.2
January	26	0	26	4	22	15.4	100.0	1:6.5	1:6.5
February	22	5	27	4	23	14.8	81.5	1:6.8	1:5.5
March	23	13	36	2	34	5.6	63.9	1:17.9	1:11.5
April	34	0	34	3	31	8.8	100.0	1:11.4	1:11.3
May	31	8	39	2	37	5.1	79.5	1:19.6	1:15.5
June	37	0	37	2	35	5.4	100.0	1:18.5	1:18.5
<u>1982/83</u>									
July	35	0	35	2	33	5.7	100.0	1:17.5	1:17.5
August	33	0	33	2	31	6.1	100.0	1:16.5	1:16.5
September	31	0	31	1	30	3.2	100.0	1:31.0	1:31.0
October	30	0	30	5	25	16.7	100.0	1:6.0	1:6.0
November	25	5	30	8	22	26.7	83.3	1:3.8	1:3.1
December	22	7	29	6	23	20.7	75.9	1:4.8	1:3.7
January	23	4	27	6	21	22.2	85.2	1:4.5	1:3.8
February	21	8	29	7	22	24.1	72.4	1:4.1	1:3.0
March	22	8	30	3	27	10.0	73.3	1:10.0	1:7.3
April	27	12	39	4	35	10.3	69.2	1:9.8	1:6.8
May	35	0	35	3	32	8.6	100.0	1:11.7	1:11.6
June	32	0	32	3	31	9.4	100.0	1:10.7	1:10.7

## Appendix A

Table A3. (Continued)

Year/ Month	Opening Stocks	Current Supply	Total Avail-	Sales	Closing	(4) as (3)-(4) % of (3)	(1) as	(4):(3)	(4):(1)
			(1)+(2)		Stocks (3)		(1) as % of (3)		
	1	2	3	4	5	6	7	8	9
	(1,000 long tons of ferti. materials)				(percent)				
<u>1983/84</u>									
July	29	0	29	1	28	3.4	100.0	1:29.4	1:29.0
August	28	0	28	3	25	10.7	100.0	1:9.3	1:9.3
September	25	5	30	1	29	3.3	83.3	1:30.3	1:25.0
October	29	19	48	4	44	8.3	60.4	1:12.0	1:7.3
November	44	15	59	11	48	18.6	74.6	1:5.4	1:4.0
December	48	0	48	8	40	16.7	100.0	1:6.0	1:6.0
January	40	10	50	6	44	12.0	80.0	1:8.3	1:7.5
February	44	0	44	10	34	22.7	100.0	1:4.4	1:4.4
March	34	0	34	5	29	14.7	100.0	1:6.8	1:6.8
April	29	1	30	6	24	20.0	96.7	1:5.0	1:4.8
May	24	9	33	4	29	12.1	72.7	1:8.3	1:6.0
June	29	30	4	4	24	13.3	96.7	1:7.5	1:7.3

Source: Data developed from Bangladesh Ministry of Agriculture, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project (Dhaka, November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued 7 August 1983 and 8 August 1984, respectively.

RECEIVED

APPROVAL

GRANT EXCHANGE CMA Chair

PRICE

ACC. NO.

VIKRAM SARABHAI LIBRARY

I. I. M. AHMEDABAD